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Cooperative Fish and Wildlife Research Units Program—2018 Year in Review

Circular 1452
Version 1.1, March 2019

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

Cooperative Fish and Wildlife Research Units Program—2018 Year in Review

By John F. Organ, John D. Thompson, Dawn E. Childs, and Donald E. Dennerline

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

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Chief's Message

The Cooperative Fish and Wildlife Research Units (CRU) program had an interesting and challenging year in 2018. We made significant strategic advances on many fronts and had setbacks in others.

Our relationship with the U.S. Fish and Wildlife Service, the agency we belonged to from 1935 to the mid-1990s, was further reinforced through strategic efforts with the Service's Science Applications senior staff. This is bearing fruit in terms of research collaborations and funding support. As part of a larger effort between the U.S. Geological Survey (USGS) Ecosystems Mission Area and the Service's endangered species program, we are also collaborating to address science needs for species in pre-listing status. Barry Grand, Unit Supervisor (South), has been instrumental in this effort.

Tom Edwards of the Utah Unit has met with representatives of the U.S. Fish and Wildlife Service and the Association of Fish and Wildlife Agencies to promote training of leaders and "hands dirty" biologists in species distribution modeling. The Association passed a unanimous resolution endorsing the training at their midyear meeting in March. Tom held a workshop at the annual meeting of the Association of Fish and Wildlife Agencies in September, and future workshops, supported by the U.S. Fish and Wildlife Service, will be held bringing State agency and U.S. Fish and Wildlife Service biologists together to work on species of common concern.

Wyoming Unit Leader Matt Kauffman's pioneering work in identifying and mapping big-game migration corridors has captured the attention of conservationists far and wide. In the spring, the Secretary of the Interior signed Secretarial Order No. 3362, "Improving Habitat Quality in Western Big-Game Winter Range and Migration Corridors" directing efforts of several U.S. Department of the Interior (DOI) bureaus to collaborate with States in identifying and protecting big-game corridors in 11 States. Matt has conducted several workshops that directly support the Secretarial order, and more are planned. Corridor mapping efforts supported by the USGS and the DOI, based in the States and coordinated by Matt, are unfolding.

Unit Administrative Officer Shana Coulby and her staff hosted a training program for university support staff at USGS National Headquarters in March. Shana's team did a superb job, and the camaraderie among all was evident.

We co-sponsored the third in a series of workshops at the North American Wildlife and Natural Resources Conference in March on bridging the gap between science and management.

The State Department requested that we coordinate a workshop that would bring CRU scientists and other U.S. representatives together with Brazilian, Colombian, and Peruvian scientists and decision makers to develop best practices to minimize environmental damage from infrastructure development in the Amazon and to collaborate on science needs. The workshop was held in Iquitos, Peru, in the heart of the Amazon during August.

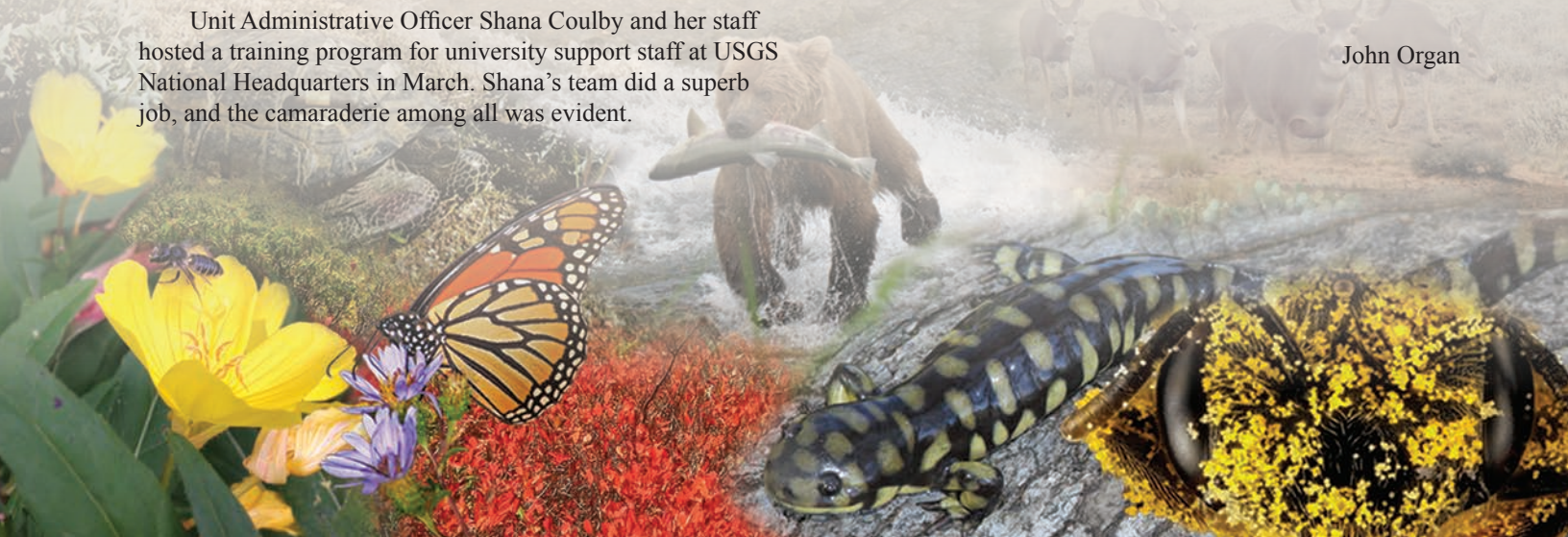
Our cooperator community, represented by the National Cooperators Coalition, was very active in response to the President's budget proposal that would have redirected funding for the CRU program to other priorities. Their efforts are reflected in the House and Senate marks on the fiscal year 2019 budget that not only restored funding, but recommended increases.

You will see in this report many other accomplishments of our individual scientists and students during 2018. It was an impressive and productive year! What you won't see chronicled is the work of the CRU headquarters staff and University support staff. These folks are extraordinary in their dedication to working with cooperators and scientists to solve problems and ensure the important work gets accomplished with minimal interference. We are truly fortunate to have such skilled and dedicated folks in the trenches.

I was fortunate to visit several units during 2018. For me, this is the most enriching part of my duties. I get to see firsthand the work our scientists do, the incredible students being mentored, and meet our cooperators on their turf.

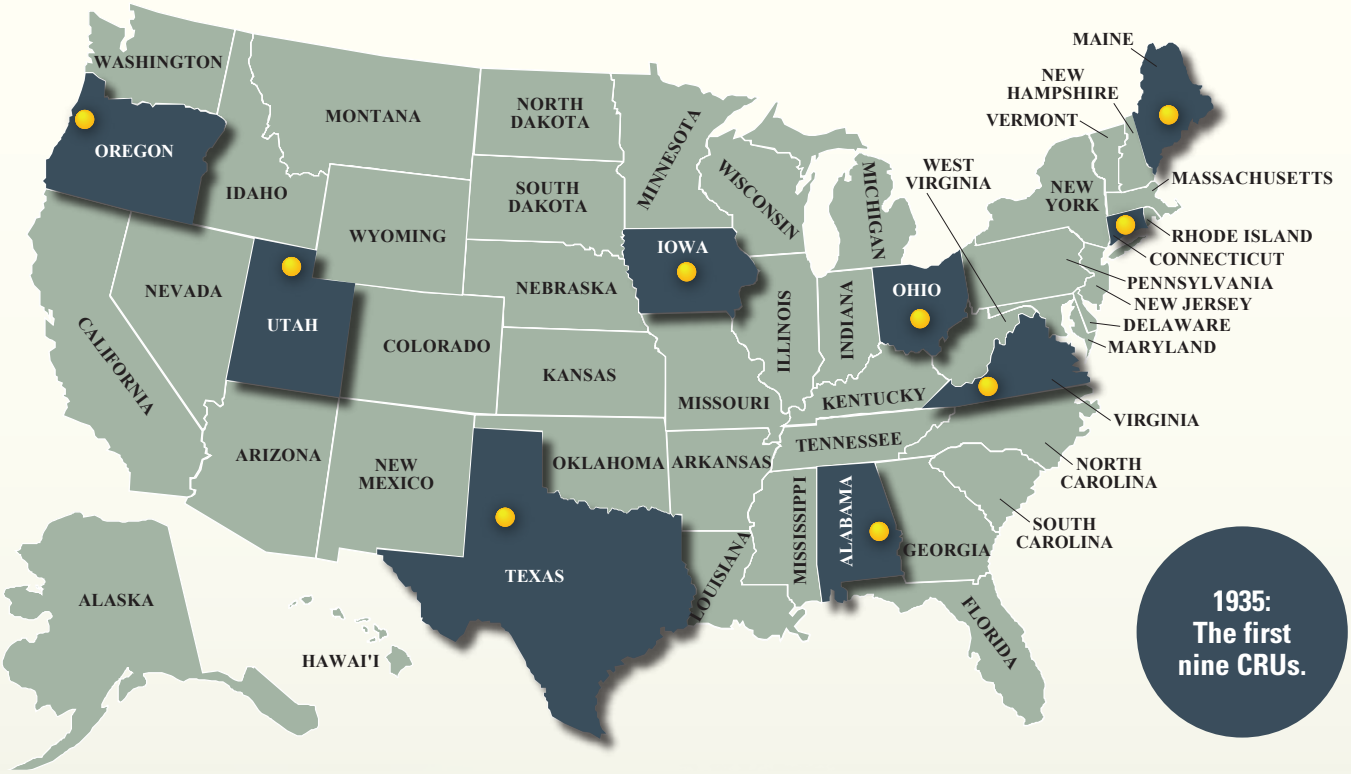
As we look forward towards the horizon, 2019 looks brighter for the CRU program. Efforts by our cooperators to generate support for filling our vacancies are materializing. Our cadre of scientists is second to none, and the breadth and depth of our work are nothing short of impressive. Thanks to all who are part of this cooperative endeavor—conservation is the ultimate winner in our efforts!

John Organ



Background

In the 1930s, Ding Darling created the first Cooperative Research Unit because of limited information on wildlife management. The first unit formed a partnership of the State land-grant (agricultural) college and the State game agency to conduct research and to provide education about wildlife at the Iowa State College in Ames. Darling and the partners expected that the unit would develop wildlife biologists and conduct relevant research. The mission of the CRU program is the following: (1) to deliver actionable science to cooperating agencies and organizations, (2) to develop the workforce of the future through applied graduate education, and (3) to fulfill the training and technical assistance needs of cooperators.



1935: The first nine CRUs.

CRU Mission and Facts

Mission

- Graduate education to develop the workforce
- Actionable research to meet cooperator science needs
- Technical assistance to cooperators on application and integration of new science

CRU Scientists

- Are embedded in the graduate faculty of universities
- Receive administrative support from the universities
- Receive graduate faculty appointments
- Are assigned office and lab space

CRU Facts

- **40 units in 38 States**
- **Research agenda: approved by the CRU Coordinating Committee including the U.S. Department of the Interior, the State fish and wildlife agency, the university, and the Wildlife Management Institute**
- **Each unit is staffed by 2–5 Federal research scientists employed by the USGS**

Outdoor Recreation Economy Statistics

In 2016, consumer spending by hunters, anglers, and target shooters supported over 1.6 million jobs.

- 13.3 million hunters and 32 million target shooters added **$55.4 billion** to the gross domestic product (GDP), providing for 854,000 jobs.
- 45.8 million angers contributed **$63.5 billion** to the Nation's GDP, supporting 802,000 jobs.
- **$93.7 billion** was spent on gear, motorboat fuel, licenses, travel, clothing, and more.

Source: Data on the Impacts of Fishing, Hunting, and Target Shooting in America Driving the U.S. Economy (Congressional Sportsmen's Foundation)

In 2017, the outdoor recreation economy generated

- **$887 billion** in consumer spending
- 7.6 million American jobs
- **$65.3 billion** in Federal tax revenue
- **$59.2 billion** in State and local tax revenue

Source: Outdoor Industry Association

The dependence by management agencies on hunter and angler participation makes understanding what drives participation in outdoor recreation critical to conservation success.

Training the Conservation Workforce—Education and Youth

Each year, more than 500 graduate students participate in natural resources education and training through the CRU program. Research directed by CRU scientists assists the next generation of professionals to emerge from our programs uniquely prepared to be effective members of the natural resource workforce. The cooperative nature of the CRU program provides this new workforce with a familiarity with the needs and policies of State and Federal science and management agencies. The success of this approach is evident in that CRU students have gone on to hold important leadership positions in nearly every State and Federal conservation agency.

- State Fish and Wildlife Agencies
- Universities
- Wildlife Management Institute
- USGS U.S. Geological Survey
- U.S. Fish and Wildlife Service

503
Graduate students in the CRU program

21
Ph.D. degrees awarded in 2018

48
M.S. degrees awarded in 2018

A new initiative, started in fiscal year 2017 as a pilot partnership program with the U.S. Fish and Wildlife Service, allows underrepresented CRU graduate and undergraduate students to conduct research on National Wildlife Refuges. Students may participate in research projects designed to provide science-based management decisions that integrate multiple objectives typical of the National Wildlife Refuge System, such as landscape connectivity, fish and wildlife health, human uses, and wildlife population management.

Leveraging Resources

The unique model of the CRU program allows each cooperator to receive much more from their individual contribution than could be achieved alone. Programwide, the 2–5 Federal research scientists stationed at host universities collectively garner $25 million to $40 million in State and Federal research funding each year. Non-Federal cooperative faculty annually bring in an additional $4.3 million in Federal funds through CRU Research Work Orders. Combined research funds at the CRUs support an average of about 1,100 students and university staff annually. Being located on some of the finest land-grant colleges and universities provides CRU researchers access to world class research and library facilities. Unit scientists and affiliated university faculty link the research mission of all cooperators with student training, thereby providing students with the applied expertise to enter the State and Federal workforce and become decision makers and managers. Base funding from the State agencies is leveraged by the other cooperators to ensure that State agencies have "local" access to state-of-the-art research capabilities and facilities to help meet their contemporary research needs.

$21.4M
in State and Federal research funding in 2018

2–5
Federal research scientists per unit

Outreach and Training

375
Scientific publications

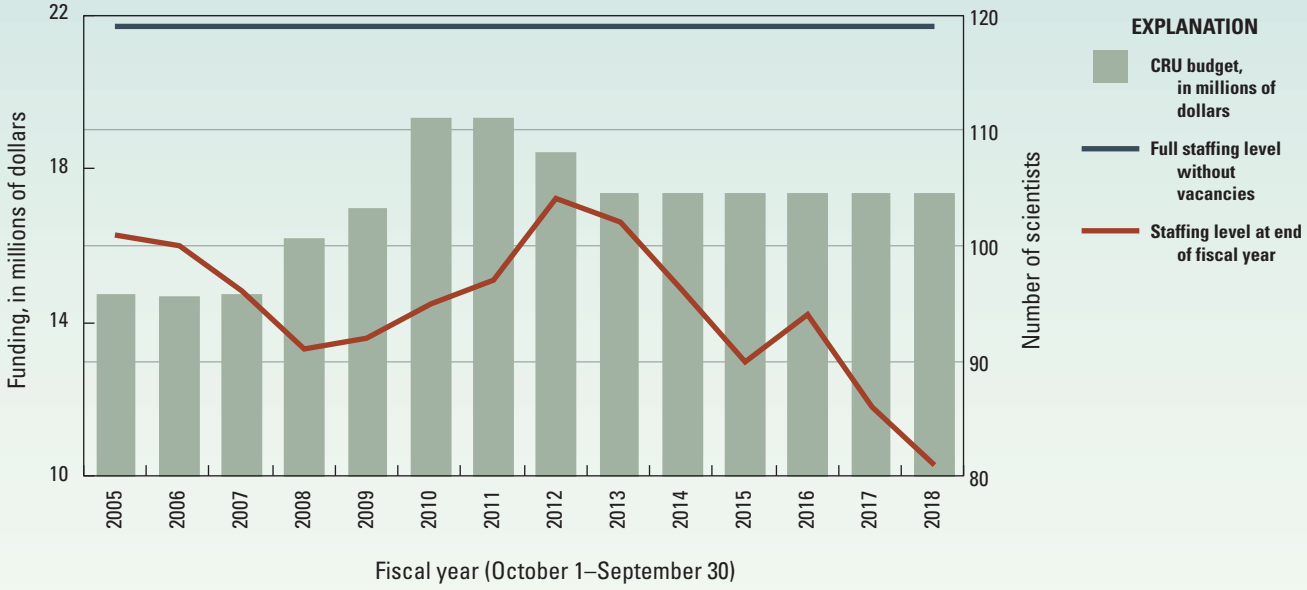
65
Courses taught

735
Presentations

32
Invited seminars

24
Workshops

Budget and Staffing



Current (2018) Vacancies

The program's 38 vacancies across the country were due to budget shortfalls.

Science Themes

We lead research that provides science-based solutions for the management needs of cooperators; science that informs decision making. Featured in this section are a few selected examples that display the diversity of management-oriented research conducted for State and Federal cooperators, aligned within science and policy themes.

Species Population, Habitat, and Harvest Management

The management of fish and wildlife populations for the benefit of current and future generations of all Americans is the foundation of this Nation's conservation heritage. We assist our cooperators in their mission through a variety of actions, from the development and implementation of basic monitoring protocols to complex population modeling. These efforts serve to facilitate the conservation and restoration of rare and declining species and to sustainably manage harvests of game and furbearer species.

The Montana Wildlife Unit is—

- Collaborating with the Montana Department of Fish, Wildlife and Parks on a wolf-monitoring study.
- Deploying camera stations to quantify cougar abundance.

The Alaska Unit is—

- Assessing the availability and use of seasonal habitats by rainbow trout in the Susitna River Basin in Alaska.
- Investigating Chinook and coho salmon productivity on the Unalakleet River.

The Montana Fishery Unit is—

- Evaluating the seasonal movements of rainbow trout, brown trout, and mountain whitefish in the Smith River, Montana.
- Partnering with Montana Department of Fish, Wildlife and Parks on a water chemistry analysis study.
- Examining the reproductive behavior ecology of pallid sturgeon in the Missouri River above the Fort Peck Reservoir.

The Arizona Unit is—

- Exploring the role of riparian vegetation and instream habitat on fish communities in Arizona.
- Examining black-tailed prairie dog taxonomy and population connectivity of the ancestral populations in Arizona to the rest of its range.
- Collaborating with the Colorado Department of Natural Resources to assess behavior ecology and genomics for pumas on the Uncompahgre Plateau of Colorado.

The Iowa Unit is—

- Leading research on amphibian occupancy and the effects of chemical exposure on habitat use of northern leopard frogs in Iowa Prairie Pothole wetlands.
- Using National Wetlands Inventory Data to model breeding populations of Canada geese in the Midwest.
- Collaborating with land managers to design a grassland bird and invertebrate response to restored plantings in northwestern Iowa.

The Massachusetts Unit is—

- Examining regeneration of forest vegetation in response to browsing by moose and deer.
- Evaluating freshwater productivity and sampling approaches for juvenile river herring in freshwater lakes and ponds.
- Investigating the effects of winter lake drawdowns on fish and wildlife.

The Kansas Unit is—

- Using acoustic telemetry to document the seasonal movement patterns of striped bass.
- Testing the selection of cover crops by pheasants relative to the availability of other cover-crop types on the landscape.

The Virginia Unit is—

- Documenting patterns of larval darter abundance in the upper Roanoke River Basin.
- Partnering with the Virginia Department of Game and Inland Fisheries to explore white-tailed deer populations in relation to landscape and land-ownership characteristics.

The Oklahoma Unit is—

- Evaluating prey consumption and body condition of sturgeon in the Missouri River.
- Evaluating the major factors driving long-term changes in northern bobwhite populations.

The Georgia Unit is—

- Partnering with the Georgia Department of Natural Resources to help formulate a trout management strategy.
- Researching whether rabbit hunting affects northern bobwhite populations.

Burlington
MASSACHUSETTS
NEW YORK
Amherst
Ithaca
RHODE ISLAND
CONNECTICUT
40°
IOWA
Ames
Lincoln
Manhattan
KANSAS
Morgantown
WEST VIRGINIA
Blacksburg
NORTH CAROLI
Clemson
Athens
SOUTH CAROLINA
Stillwater
OKLAHOMA
ARKANSAS
Mississippi
ALABAMA
Auburn
GEORGIA
TEXAS
Gainesville
FLORIDA
100°
90°
80°

EXPLANATION

Cooperative Research Unit (CRU) location

0 100 200 300 400 500 MILES

0 100 200 300 400 500 KILOMETERS

Universal Transverse Mercator projection, zone 14

Species Population, Habitat, and Harvest Management—Continued

The Oregon Unit is—

- Examining Columbia River fish using passive integrated transponders (PITs) and active tags such as the Juvenile Salmonid Acoustic Telemetry System, important tools for evaluating juvenile passage and adult return.
- Evaluating survival of suckers in Upper Klamath Lake.
- Assessing the effects of recolonizing gray wolf populations on cougars in northeast Oregon.

The South Dakota Unit is—

- Evaluating the effectiveness of alfalfa for nesting habitat and seedbed preparation as a new approach for managing grasslands that support ring-necked pheasant and waterfowl for hunters.
- Partnering with the South Dakota Department of Game, Fish, and Parks to evaluate growth potential and genetic diversity of yellow perch, an important sport fish.
- Evaluating the settling dynamics of breeding ducks in the U.S. Prairie Pothole Region.
- Researching the growth rates of brown trout in Spearfish Creek, South Dakota.

The Missouri Unit is—

- Conducting a special assessment of the status and risks to mussel concentrations in the Meramec River drainage basin.
- Determining electrofishing immobilization thresholds of smallmouth bass, blue catfish, and flathead catfish—a critical step to develop a standardized sampling protocol.
- Developing stream temperature models for selected Missouri streams.

The New Mexico Unit is—

- Assessing the response of lesser prairie-chickens to mesquite removal, prescribed fire, and grazing in the shinnery oak prairie ecoregion of eastern New Mexico.
- Examining seasonal movement patterns of band-tailed pigeons.
- Describing seasonal movement patterns of wintering sandhill cranes in the Middle Rio Grande Valley.
- Researching the population and density of mountain lions.

The Minnesota Unit is examining sandhill crane movement patterns by attaching Global Positioning System (GPS) transmitters to inform harvest management strategies.

The Vermont Unit is investigating the rates of moose mortality, productivity, and recruitment.

The Colorado Unit is collaborating with scientists at Colorado Parks and Wildlife to understand the movement of lynx and cougar in Colorado.

The Maine Unit is partnering with the Maine Department of Inland Fisheries and Wildlife to optimize commercial white sucker harvest.

The Mississippi Unit is—

- Developing live-well management procedures to improve the survival of largemouth bass.
- Developing new monitoring protocols for fisheries.

The Tennessee Unit is—

- Sampling catfish stocks in Tennessee reservoirs.
- Using genetic techniques to evaluate stocked Florida largemouth bass in the Chickamauga Reservoir fishery.

The Pennsylvania Unit is collaborating with the Pennsylvania Game Commission to monitor deer fawn survival and mortality and the distribution of predators (black bear, coyote, and bobcat) across Pennsylvania.

Universal Transverse Mercator projection, zone 14

Species Population, Habitat, and Harvest Management—Continued

The Idaho Unit is—

- Using the National Gap Analysis Program (GAP) species distribution models for marsh birds to identify important threats and map variation in habitat across the species' range.
- Developing range-wide habitat models for predicting habitat suitability of marsh birds throughout Idaho.
- Tracking life history characteristics, distribution, and habitat use of westslope cutthroat trout in the St. Maries River Basin.

The California Unit is—

- Detecting coho salmon using environmental DNA (eDNA).
- Examining how oysters influence benthic invertebrate communities in Humboldt Bay, California.
- Collaborating with the California Department of Fish and Wildlife to conduct sampling of streams defined in the Coastal California Salmonid Monitoring Plan.

The Utah Unit is leading research on the importance of the Logan River Blue Ribbon trout fishery by synthesizing nearly 15 years of data into an integrated population model to empower the Utah Division of Wildlife Resources to evaluate management options and predict the potential impact of a dam and reservoir on the Temple Fork tributary.

The Texas Unit is—

- Evaluating the effects of drought and anthropogenic influences on the growth of stream fishes on the Edwards Plateau.
- Estimating the survival and connectivity of midcontinental snowy plovers at interior nesting locations in Kansas, New Mexico, Oklahoma, and Texas.

The New York Unit is—

- Using capture-recapture techniques to estimate fisher density across the southern tier of New York.
- Conducting a Great Lakes cisco spawning habitat assessment.
- Integrating citizen science to monitor and estimate black bear populations in New York.
- Developing models to evaluate the population status of select carnivore species.
- Investigating the declines in the moose population in New York.

The South Carolina Unit is—

- Modeling bat habitat use across Big South Fork National River and Recreational Area.
- Assessing species composition, distribution, and abundance of seabirds in the Gulf of Mexico, satisfying a portion of the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPS).
- Modeling winter habitat use of whooping cranes in the eastern migratory population.

The North Carolina Unit is—

- Sampling American eels in the Roanoke River.
- Investigating factors influencing native aquatic plants to enhance sport fish habitat in North Carolina Piedmont reservoirs.
- Documenting stocked trout survival, behavior, and ecology in North Carolina streams.

Species of Greatest Conservation Need

To obtain funding under the State Wildlife Grants Program, States are mandated by Congress to develop a State Wildlife Action Plan (SWAP). SWAPs contain a list of species of greatest conservation need (SGCN) and identify the information needs, threats, and conservation actions pertinent to them. CRU scientists work with state cooperators to develop the science needed to inform conservation actions.

The Idaho Unit is—

- Evaluating the effects of spring cattle grazing on demographic traits and habitat characteristics of greater sage-grouse.
- Identifying migratory routes and wintering grounds of burrowing owls on U.S. Department of Defense installations in the Western United States.
- Working with the Idaho Department of Fish and Game to evaluate kokanee breeding groups in Idaho.

The South Dakota Unit is assessing the status of reintroduced swift fox in southwestern South Dakota.

The Wyoming Unit is—

- Researching the distribution, abundance, habitat, and disease of the Columbia spotted frog in Wyoming.
- Investigating black rosy-finch distribution, abundance, and habitat selection during the breeding season.
- Leading research on bird responses to restoration in sagebrush-steppe ecosystems in Grand Teton National Park.

The Colorado Unit is—

- Collaborating with Colorado Parks and Wildlife to evaluate spatial data for Gunnison sage-grouse.
- Assessing eagle nest survival and raptor species distribution.

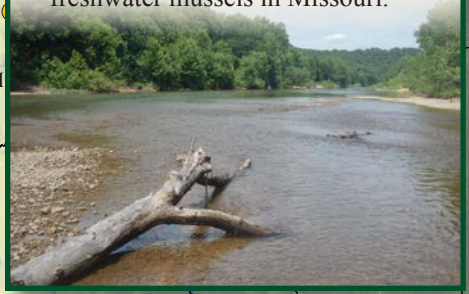
The Minnesota Unit is evaluating movements of golden-winged warblers.

The Maine Unit is investigating the effects of forest management practices on forest bird communities in Maine.

The Iowa Unit is using state-of-the-art geographic information systems (GISs) to guide future habitat restoration efforts for Topeka shiner and plains topminnows.

The West Virginia Unit is collaborating with State agencies in Kentucky, Pennsylvania, Virginia, and West Virginia to evaluate the response of cerulean warblers and associated species to forest management practices.

The Missouri Unit is developing models that identify factors affecting the capture probability of freshwater mussels in Missouri.



The Virginia Unit is leading research on the distribution, habitat use, and genetic status of eastern spotted skunk, a rare species throughout the Appalachians.

The Louisiana Unit is evaluating the effects of flooding, nest predation, and other factors on nest success of waterbirds in Louisiana.

Universal Transverse Mercator projection, zone 14

Species of Greatest Conservation Need—Continued

The Washington Unit is—

- Testing drone-based sampling and collaborating with the State of Washington to understand the factors that influence site occupancy of common loon based on existing survey data as well as citizen science (eBird) data.
- Developing a juvenile salmonid health index at National Water-Quality Assessment Program sites.

The California Unit is—

- Evaluating the role of fishless headwater streams as donors to downstream food supplies for coastal cutthroat trout in the lower Klamath River.
- Testing the effectiveness of a supplemental feeding program to increase giant kangaroo rat populations.
- Leading research on Townsend's big-eared bats and other bat species identified as species of greatest conservation need in the California Department of Fish and Wildlife 2015 SWAP.

The Utah Unit is locating preferred spawning and rearing habitat of bluehead sucker in the Weber River, Utah.

The Arizona Unit is examining the relationship of riparian and instream habitat with presence of native and nonnative fishes.

The Alaska Unit is—

- Investigating the ecology of Smith's longspurs in northern Alaska.
- Evaluating migration trends for king and common eiders and yellow-billed loons.

The Montana Fishery Unit is—

- Surveying pearl dace and the northern redbelly dace to help the Montana Department of Fish, Wildlife and Parks identify and prioritize potential areas and opportunities for long-term conservation.
- Investigating landscape connectivity of Arctic grayling in the Big Hole River watershed in Montana.

The Massachusetts Unit is leading research on brook floater, a stream-dwelling freshwater mussel that has experienced large declines over the past 50 years and is at high risk of extinction.

The Arkansas Unit is—

- Exploring the effects of wetland management strategies on habitat use of fall migrating rails on managed wetlands.
- Examining the invasive species effects, population status, and population genetics of crayfish in the Ozark Highlands of Arkansas and Mississippi.

The Kansas Unit is providing baseline data on the health and the reproduction status of lesser scaup.

The Tennessee Unit is evaluating the distribution of imperiled mussels in Tennessee waters.

The North Carolina Unit is leading research on distribution and abundance of the Carolina madtom, a small catfish endemic to a restricted range in the Neuse and Tar River Basins of North Carolina.

CANADA
UNITED STATES
MINNESOTA
WISCONSIN
MICHIGAN
NEW YORK
PENNSYLVANIA
RHODE ISLAND
CONNECTICUT
NEW JERSEY
MARYLAND
DELAWARE
DISTRICT OF COLUMBIA
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
KANSAS
OKLAHOMA
TEXAS
ARKANSAS
TENNESSEE
MISSISSIPPI
FLORIDA
St. Paul
Stevens Point
Brookings
Madison
Ithaca
Amherst
University Park
Morgantown
Princess Anne
Blacksburg
Raleigh
Lincoln
Manhattan
Stillwater
Fayetteville
Cookeville
Clemson
Athens
Mississippi State
Gainesville
70°
40°
30°
90°
80°

EXPLANATION

Cooperative Research Unit (CRU) location

0 100 200 300 400 500 MILES

0 100 200 300 400 500 KILOMETERS

Universal Transverse Mercator projection, zone 14

Energy and Wildlife

Biologists and land managers need information on impacts of energy development on fish and wildlife species and risk analyses related to different options for energy infrastructure siting. CRU scientists work with cooperators to provide a science foundation for their decisions.

The Montana Wildlife Unit is leading research on amphibian exposure to sublethal stressors in wetlands affected by energy development in the Williston Basin of North Dakota and Montana.

The Wyoming Unit is—

- Examining the influence of energy development on nongame sagebrush birds.
- Leading research on the influence of energy development on mule deer migrations.
- Investigating the effects of energy development on Colorado River cutthroat trout, mountain sucker, mottled sculpin, and speckled dace.

The New Mexico Unit is—

- Examining the distribution of golden eagles in areas with high potential for wind energy development.
- Investigating impacts of energy development on lesser prairie-chicken.


The West Virginia Unit is evaluating Louisiana waterthrush and avian response to shale gas development in the central Appalachian region.
The Kansas Unit is investigating the impacts of energy production, habitat selection, and population size on recruitment of lesser prairie-chicken in Colorado, Kansas, and Oklahoma.
CANADA
UNITED STATES
MINNESOTA
KANSAS
OKLAHOMA
TEXAS
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
NEW HAMPSHIRE
VERMONT
MAINE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW JERSEY
DISTRICT OF COLUMBIA
MARYLAND
DELAWARE
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
FLORIDA
Orono
Burlington
Amherst
Ithaca
University Park
Princess Anne
Morgantown
Blacksburg
Raleigh
Clemson
Athens
Gainesville
Brookings
Ames
Lincoln
Columbia
Manhattan
Stillwater
Cooperative Research Unit (CRU) location
0 100 200 300 400 500 MILES
0 100 200 300 400 500 KILOMETERS
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Universal Transverse Mercator projection, zone 14

Decision Science

Decision science is becoming an essential approach to enable transparent, quantifiable decisions in the face of uncertainty and contention, and to allow managers and scientists to learn through management actions.

The Idaho Unit is investigating the distribution and movement of wild and hatchery steelhead and the connection with angling across the State.

The Colorado Unit is using an adaptive management framework to inform migratory bird habitat conservation and harvest decisions.

The Alaska Unit is—

- Developing a landscape conservation approach in the northwest boreal and western Alaska regions in response to climate change.
- Leading research on social-ecological resilience and response to climate change by integrating research on fire, landscape structure, ecosystem function, and social-ecological dynamics of rural Alaskan villages.
- Using a science-decision framework to engage land managers in identifying conservation and management objectives under a suite of climate scenarios.

The Massachusetts Unit is—

- Testing a decision-support tool to examine fish species affected by dams.
- Using a structured decision-making process to address the conservation of headwater stream ecosystems.

The Missouri Unit is partnering with the Missouri Department of Conservation to develop a decision-support monitoring framework designed to maximize the probability of detecting species declines in key areas of Missouri that are the strongholds of mussel diversity.

The Alabama Unit is—

- Partnering with the Alabama Department of Conservation and Natural Resources to conduct long-term research to inform science-based management of eastern wild turkey populations.
- Using a structured decision-making framework to investigate viable options for the restoration of Dauphin Island.
- Developing a decision model for the management and recovery of grassland birds and other wildlife species.

The Mississippi Unit is working with the Mississippi Department of Wildlife, Fisheries, and Parks to develop new standardized protocols to support statewide fisheries management activities.

The Louisiana Unit is—

- Collaborating with Deepwater Horizon oil spill trustees and State and Federal agencies to develop a framework that will enable the evaluation of restoration effectiveness to inform future management decisions.
- Collaborating with the Jean Lafitte National Historical Park and Preserve and other key stakeholders on a coastwide model to inform restoration options for over 50 acres of submerged aquatic vegetation in the park.

Endangered Species

Unit scientists work with Federal and State cooperators to provide answers to science questions that inform decision making in implementing the Endangered Species Act.

The Washington Unit is leading research on the diets of juvenile suckers in the Upper Klamath Basin using fatty-acid-based mixing models.

The Idaho Unit is—

- Assessing the importance of wetlands on over 600 U.S. Department of Defense (DOD) installations for wetland-dependent birds; the project will produce a first-of-its-kind inventory of the biological value of wetlands on DOD lands, detailed habitat models for each species, and baseline survey data of secretive marsh birds.
- Researching the effectiveness of forest restoration treatments on the demography of the Northern Idaho ground squirrel.

The California Unit is—

- Acquiring baseline data throughout the range of the giant kangaroo rat to formulate long-term management and recovery of the species.
- Characterizing the foraging ecology of marbled murrelets in coastal waters adjacent to old-growth redwood forests.
- Investigating coho salmon in Prairie Creek subbasin, recognized as being critically important for recovery of coho salmon and steelhead trout within Redwood Creek.

The Utah Unit is—

- Leading research on how endangered fish species are monitored.
- Using passive integrated transponder tags on four federally listed fish (Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub) in the Colorado River Basin.
- Developing species distribution models on 35 species in the Uinta-Wasatch-Cache National Forest.
- Investigating rare plant species on Bureau of Land Management lands.

The Iowa Unit is monitoring Topeka shiner in two streams in the Boone River watershed—White Fox Creek and Eagle Creek—two oxbows that support the only known remnants of the Topeka shiner distribution in the Boone River watershed.

The Maine Unit is—

- Using acoustic telemetry to estimate the survival of Atlantic salmon in the Penobscot River.
- Assessing the regional effects of acid and aluminum exposure on Atlantic salmon juveniles.
- Investigating sea lamprey biology and interaction with Atlantic salmon in Maine rivers.

The Wisconsin Fishery Unit is developing environmental DNA (eDNA) techniques for detection of purple cat's paw pearlymussel and snuffbox.

The West Virginia Unit is examining the macrohabitat use and abundance of diamond darter in the lower Elk River.

The Tennessee Unit is leading research on the ecology of endangered and common mussels below a Green River Lake Dam.

The Georgia Unit is—

- Leading research on black rail ecology. The black rail is currently under review by the U.S. Fish and Wildlife Service (USFWS) for protection under the Endangered Species Act.
- Helping State agency resource managers in the northern recovery unit to identify uncertainties in loggerhead sea turtle demography.
- Working with State wildlife agencies and other partners, through the Southeastern Association of Fish and Wildlife Agencies, to assess the status of over 300 species awaiting reviews for listing decision and to implement conservation for these species on public and private lands.

CANADA
UNITED STATES
MINNESOTA
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WEST VIRGINIA
DISTRICT OF COLUMBIA
DELAWARE
KANSAS
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TEXAS
ARKANSAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
TENNESSEE
Orono
Burlington
St. Paul
Stevens Point
Brookings
Madison
Ithaca
Ames
Lincoln
Morgantown
Princess Anne
Manhattan
Cookeville
Stillwater
Fayetteville
Clemson
Athens
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EXPLANATION

Cooperative Research Unit (CRU) location

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Universal Transverse Mercator projection, zone 14

Endangered Species—Continued

The Montana Wildlife Unit is—

- Using noninvasive collecting techniques and molecular genetics monitoring tools to develop a comprehensive understanding of greater sage-grouse genetic connectivity across Montana, North Dakota, South Dakota, and Wyoming.
- Acquiring data on the grizzly bear population status in the Cabinet-Yaak ecosystem using noninvasive genetic sampling.

The Nebraska Unit is deploying ultrasonic acoustic detectors to identify when and where bats are moving in eastern Nebraska during spring and fall migration and summer residence.

The Montana Fishery Unit is—

- Assessing the density of pallid sturgeon and examining food web dynamics in the Missouri River.
- Investigating the environmental factors affecting egg quality and caviar yield in farmed sturgeon.
- Evaluating juvenile bull trout in the Thompson Falls reservoir.

The New Mexico Unit is—

- Investigating seasonal use of conservation reserve program habitat by the lesser prairie-chicken in eastern New Mexico.
- Developing a screening tool to identify the presence of Asian tapeworm in imperiled native fish populations in the southwestern United States.
- Examining population dynamics and reintroduction characteristics of Mexican wolves in the Blue Range Wolf Recovery Area in Arizona and New Mexico.

The Kansas Unit is assessing aspects of livestock grazing and prescribed fire as management tools by quantifying vegetation structure, vegetation composition, and lesser prairie-chicken population response to grazing management and use of fire in Kansas.

The Massachusetts Unit is—

- Testing the feasibility of mussel propagation at the USFWS Richard Cronin Aquatic National Salmon Station.
- Monitoring the northern red-bellied cooter.
- Investigating alewife population dynamics in the Parker River.
- Sequencing the genome for Canada lynx to aid in the development of post de-listing monitoring and other conservation measures.

The North Carolina Unit is—

- Assessing marsh rabbit and woodrat habitat use and feral cat population dynamics using photographic, video, and capture-recapture data.
- Examining the sicklefin redhorse priority habitats in regulated rivers in the southern Appalachian Mountains.

The Missouri Unit is collaborating with the Missouri Department of Conservation on the development of a decision-support monitoring framework designed to maximize the probability of detecting threatened or endangered freshwater mussels.

The Oklahoma Unit is—

- Assessing distribution of Yaqui catfish in the Rio Yaqui drainage—the only shared basin between the United States and Mexico where Yaqui catfish occur.
- Developing a niche model to determine the distribution of longnose darter.

The Florida Unit is researching the composition, distribution, and ecology of sea turtles across the State.

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UNITED STATES
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MINNESOTA
St. Paul
Stevens Point
WISCONSIN
MICHIGAN
Madison
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Amherst
Ithaca
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DISTRICT OF COLUMBIA
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NEBRASKA
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Cooperative Research Unit (CRU) location

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Universal Transverse Mercator projection, zone 14

Invasive Species

Invasive species of plants, animals, and microorganisms pose significant risks to native species, ecosystems, and the health of humans, fish, and wildlife. The economic, environmental, and health-related costs of invasive species exceed those of all other natural disasters combined. Biological invasions may affect the resilience of complex systems and can cause sudden and essentially irreversible changes.

The Idaho Unit is—

- Researching the population structure of invasive common carp and identifying the best techniques for removal.
- Sampling and evaluating the population dynamics of burbot in the Green River system.

The Utah Unit is investigating the most effective strategies for controlling common reed (*Phragmites*) and restoring migratory bird habitat at the Bear River Migratory Bird Refuge.

The Montana Fishery Unit is—

- Researching the effects of walleye and yellow perch on the trout fishery in Buffalo Bill Reservoir and the North Fork Shoshone River.
- Evaluating viable suppression methods to induce mortality in lake trout embryos in lakes throughout the West.
- Identifying the threats of smallmouth bass on Yellowstone cutthroat trout in the Yellowstone River.

The Arizona Unit is—

- Leading research on habitat suitability criteria for nonnative fish in Arizona streams.
- Investigating the relationship between native and nonnative fish in the Mogollon Rim area.
- Modeling the feasibility of integrated control of channel catfish, green sunfish, mosquitofish, red shiner, and other nonnative species.

The Texas Unit is evaluating the influence of environmental variables on growth of toxigenic golden algae.

The New Mexico Unit is investigating patterns of resource use for feral burro and coyote on the National Training Center, Fort Irwin, Calif.

Universal Transverse Mercator projection, zone 14

Ecosystem Services

An ecosystem service is any positive benefit provided to society by fish, wildlife, or components of ecosystems through their functions. Public and private support for natural resource conservation can be fostered through increased awareness and understanding of the many benefits healthy ecosystems provide to society. Ecosystem services can be documented through nonmonetary or cultural values. Cultural ecosystem services are more difficult to quantify, but extremely important in understanding natural resource values to society.

The Hawaii Unit is—

- Assessing the functional equivalency of Hawaiian fishponds, an important cultural and economic resource for native Hawaiians, relative to natural estuaries for nearshore fisheries.
- Evaluating the impacts of changing nearshore environments on fish assemblage structure.
- Investigating the life-history and population structure of introduced predators on Hawaiian reefs.

The Texas Unit is partnering with the Texas Parks and Wildlife Department to assess and monitor public river access leases.

The New Mexico Unit is partnering with the U.S. Environmental Protection Agency's Sustainable and Healthy Communities Research Program and the National Gap Analysis Program to facilitate the use of GAP data and models for ecosystem services.

The Alaska Unit is modeling landscape vulnerability to thermokarst disturbance and its implications for ecosystem services in the Yukon Flats National Wildlife Refuge, Alaska.


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The Missouri Unit is examining the potential for conservation lands in the middle Mississippi River floodplains to mitigate flood flows for ecosystem services.
The Arkansas Unit is—
• Supporting the Pollinator Health Task Force initiatives by assessing pollinator diversity and abundance on National Wildlife Refuges and other private and public lands in the Lower Mississippi Alluvial Valley of Arkansas.
• Surveying pollinator wetland communities to document species richness and diversity.
The Oklahoma Unit is incorporating an approach to aid river and reservoir fisheries in an altered landscape.
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Cooperative Research Unit (CRU) location
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Universal Transverse Mercator projection, zone 14

Ecological Flows

The assessment and prescription of ecological flows require water resource managers and researchers to access and analyze several different types of data and select appropriate tools and approaches from a wide variety of established methodologies.

The Washington Unit is assessing marine biodiversity in the Elwha River nearshore using environmental DNA (eDNA).

The Oregon Unit is identifying physical and biological habitat needs of native fish species that will allow for improved habitat management and provide information to aid in protection of instream flows.

The Montana Fishery Unit is—

- Evaluating sediment and nutrient contributions from unpaved forest roads to headwater streams.
- Investigating the passage efficacy of Denil fishways placed in the Big Hole River watershed designed to improve migration corridors for Arctic grayling.

The Colorado Unit is collaborating with Colorado Parks and Wildlife and the City of Longmont to understand the habitat requirements of stonecat in an urban setting. The data will inform future urban stream management in tandem with managing for sensitive fishes.

The New Mexico Unit is—

- Leading research on the current and future distribution of native fishes in the Gila and Mimbres drainages.
- Investigating influences of changes in discharge and stream temperature on cutthroat trout in the Southwest.


The South Dakota Unit is leading research on the effects of water velocity and temperature on energy reserves of pallid sturgeon.
The Missouri Unit is—
• Leading research on fish community response to stream flow alterations in wadable Missouri streams.
• Investigating how reservoir releases affect habitat selection of river fish.
• Researching dissolved oxygen and river flow in the lower Osage River.
The Massachusetts Unit is examining the effects of surface-water supply reservoirs on streamflow.
The Mississippi Unit is—
• Evaluating movement (river conditions, water-release flows) and seasons in the lower Mississippi River to identify strategies to aid in the recovery of the pallid sturgeon.
• Quantifying entrainment rates for pallid sturgeon and shovelnose sturgeon and identifying flow management alternatives to reduce entrainment.
The Louisiana Unit is—
• Monitoring water quality, habitat, and fish communities in the Atchafalaya River Basin.
• Examining hydrologic alternations in bottomland hardwood trees in the Mississippi Alluvial Valley.
The Georgia Unit is leading research on the potential conservation benefits of forestry management best practices for sensitive aquatic species in the southeastern United States.
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Wildlife Health and Disease

Wildlife diseases pose potential threats to the viability of wildlife populations and have potential implications to human health and our economy. CRU scientists work with cooperators to better understand the causes of these diseases, the impacts on wildlife and people, and means to control, contain, and eradicate them.

The Washington Unit is—

- Investigating destructive pathogens to Chinook salmon and impacts on other salmonids in the Pacific Northwest.
- Assessing the impact of environmental contaminants (endocrine disrupting compounds) on fish health.

The Oregon Unit is—

- Evaluating survival of adult and juvenile bighorn sheep in the Mojave National Preserve in response to respiratory disease.
- Leading research on salmon disease in the Klamath River.

The Idaho Unit is—

- Leading research on the effects of sylvatic plague on northern Idaho ground squirrels.
- Examining how the introduction of nonnative species into an ecosystem can alter the dynamics of energy transfer and food webs or adversely affect native species via disease or competition.

The Wyoming Unit is—

- Investigating the nutritional carrying capacity for bighorn sheep.
- Investigating elk movement and winter-range connectivity to predict the spread of brucellosis.

The Colorado Unit is leading research on the survival of rainbow trout.

The New Mexico Unit is examining the impacts of coyotes on Fort Irwin, Calif., to develop a mitigation strategy that can be adopted by the base to minimize human-wildlife conflict and the spread of disease to humans and pets.

The Wisconsin Wildlife Unit is—

- Leading research on white-tailed deer population dynamics in the wake of chronic wasting disease.
- Investigating how the fungus that causes white-nose syndrome in hibernating bats differs among groups of bats that are either resistant or susceptible to the disease.
- Partnering with the U.S. Department of Defense to evaluate the potential effects of climate change on plague exposure pathways in prairie dogs, ground squirrels, and other rodents.

The New York Unit is collaborating with the New York State Department of Environmental Conservation to examine moose density in New York in relation to density dependent diseases.

The Arkansas Unit is investigating the effects and sources of strontium in lesser scaup.

The Pennsylvania Unit is—

- Investigating the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River Basin.
- Determining how breeding amphibians respond to annual variation in weather and disease.
- Establishing a strategy for assessing risk of endocrine disrupting chemicals to aquatic and terrestrial organisms.
- Assessing population structure of white-tailed deer for surveillance of chronic wasting disease.

The South Carolina Unit is evaluating the effect of white-nose syndrome on bats.

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Landscape Ecology

Landscape ecology is the study of the origin, structure, and dynamics of ecosystem components across broad geographic or watershed scales. It includes analysis of spatial and temporal information, effects of stressors, and how the information can be scaled to address specific management needs and support decision making.

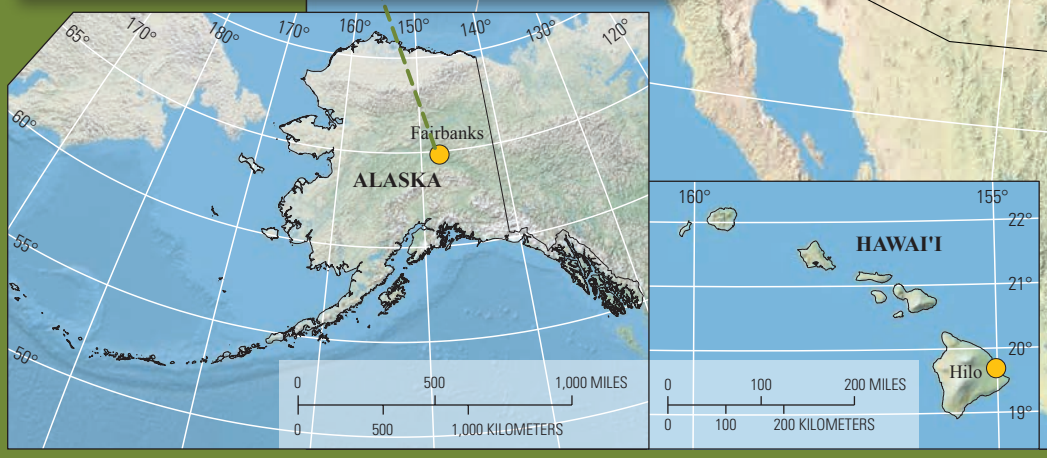
The Alaska Unit is—

- Evaluating moose spatial habitat use on the Kanuit National Wildlife Refuge.
- Applying an integrated ecosystem model to understand potential landscape, habitat, and ecosystem change in Alaska and northwest Canada.
- Assessing connectivity for landscape conservation design and adaptation planning.
- Assessing historical and projected changes in carbon storage in Alaska.
- Evaluating landscape changes associated with social-ecological systems on the Kenai Peninsula.

The Nebraska Unit is monitoring amphibian occupancy, functional connectivity, and resilience of Rainwater Basin wetlands.

The New Mexico Unit is—

- Monitoring the responses of mule deer, elk, black bear, and mountain lion to forest restoration treatments associated with the Southwest Jemez Mountains Collaborative Forest Landscape Restoration Project.
- Researching the influence of fire and forest restoration on spatial and temporal distribution of fish and aquatic invertebrate communities.

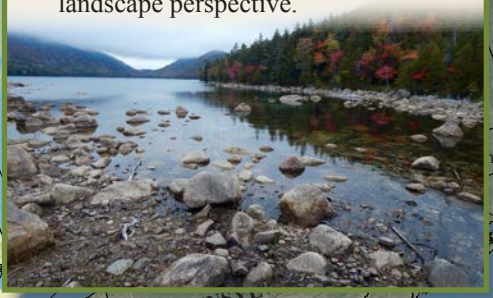


The Wisconsin Wildlife Unit is—

- Investigating landscape-scale management of forest wildlife populations.
- Monitoring density and nest success of grassland birds in warm season conservation reserve program fields in southwestern Wisconsin.

The Maine Unit is—

- Developing models to predict a landscape's ability to support a variety of forest bird species.
- Organizing a team of ecologists and economists from multiple subdisciplines and institutions to explore the biophysical and socioeconomic components of vernal pools from a landscape perspective.



The Pennsylvania Unit is designing an ecology framework to better predict nutrient patterns for all continental U.S. lakes to inform global cycles of nitrogen, phosphorus, and carbon, while also providing locally valuable information about conditions in unsampled lakes.

The West Virginia Unit is—

- Monitoring how Corridor H, a four-lane highway under construction in eastern West Virginia, will influence stream health and stream sedimentation during the construction process.
- Evaluating genetic- and landscape-level threat assessments of the candy darter.
- Partnering with the West Virginia Division of Natural Resources and the Wildlife Management Institute to examine methods for creating young forest habitat for birds and terrestrial salamanders.

The North Carolina Unit is investigating applications in support of the National Gap Analysis Program to help natural resource managers develop better monitoring protocols.

Landscape Ecology—Continued

The Wyoming Unit is—

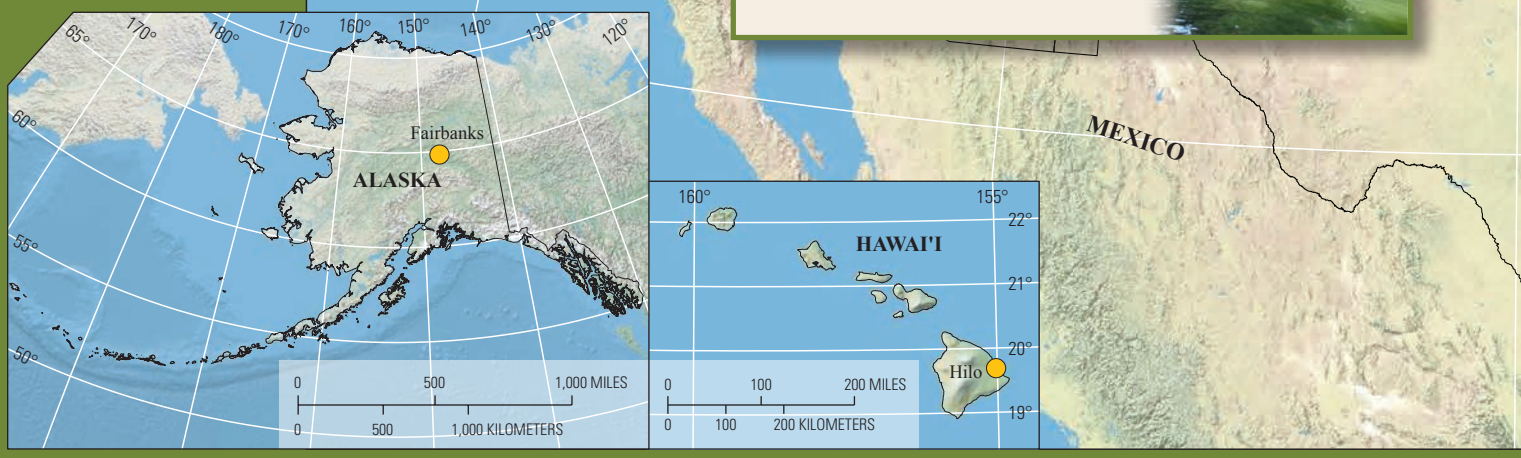
- Evaluating the threats that face the key documented migration corridors of big-game herds in Wyoming.
- Using geospatial modeling to determine existing ungulate migration corridors and landscape connectivity throughout Wyoming.

The Utah Unit is—

- Investigating the effects of wildfire on fish populations and stream geomorphology in Twitchell Canyon.
- Developing species and habitat sampling and distribution modeling protocols on the Colorado plateau.

The Mississippi Unit is—

- Researching the establishment of agricultural plantings on mudflats to create suitable fish habitat.
- Inventorying and classifying oxbow lakes in the Mississippi Alluvial Valley.




The Vermont Unit is developing methods to implement wildlife monitoring projects that produce high-quality, high-resolution data for landscape-scale community monitoring.
The Missouri Unit is—
• Evaluating grassland restoration efforts on invertebrate communities.
• Researching science information needs for management of conservation lands on large tracts of Mississippi and Missouri River floodplains.
The Massachusetts Unit is—
• Providing a synthesis of river herring and modeling the food web in the St. Croix River.
• Exploring how land-use patterns have influences American black bear and Peruvian Andean bear distributions.
The Georgia Unit is—
• Assessing field- and landscape-level effects of U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) conservation practices on gopher tortoise habitat.
• Integrating metapopulation ecology and landscape ecology for improved population viability analysis and conservation decision making for the Chiricahua leopard frog.
CANADA
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VERMONT
Burlington
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University Park
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Brookings
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INDIANA
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WEST VIRGINIA
Columbia
Manhattan
KANSAS
MISSOURI
KENTUCKY
Cookeville
TENNESSEE
NORTH
Stillwater
Fayetteville
ARKANSAS
Clemson
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OKLAHOMA
Mississippi State
ALABAMA
Auburn
GEORGIA
MISSISSIPPI
LOUISIANA
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Baton Rouge
Gainesville
EXPLANATION
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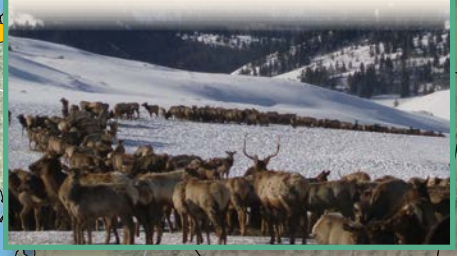
Human Dimensions of Fish and Wildlife Conservation

Human dimensions of fish and wildlife conservation is the application of social science to management issues. Integration of human dimensions and ecological science allows for greater insights into management solutions and, ultimately, more durable decisions.

The Minnesota Unit is leading research on private landowner perceptions in the walk-in access program—the information collected will provide a better understanding of the variables that best predict landowners' decisions to enroll property in the program.

The Wyoming Unit is assessing how hunters change their use of the forest and where they choose to hunt elk throughout all stages of the beetle kill and tree fall.



The Nebraska Unit is designing a comprehensive evaluation of the Nebraska outdoor enthusiast by researching hunting and fishing license purchasing patterns.


The Wisconsin Wildlife Unit is evaluating levels of participation, direct expenditures, indirect economic benefits, and expenditures of wildlife management in the United States.
The New York Unit is examining opportunities for local-level stakeholder engagement in landscape conservation design.
The South Dakota Unit is investigating human dimensions of habitat loss in the plains and Prairie Pothole Region.
The Massachusetts Unit is—
• Assessing the values, expectations, and satisfaction of hunters regarding white-tailed deer hunts in suburban eastern Massachusetts.
• Assessing deer hunter attitudes and values related to use of non-lead ammunition for deer hunting on National Wildlife Refuges in the northeast.
The Virginia Unit is partnering with the Intermountain West Joint Venture to understand the perceptions, values, and interests of key stakeholders and associated incentives for cooperative conservation in wet meadow habitats in sage-steppe landscapes.
The Georgia Unit is—
• Providing ecological information to leverage the needs of conservation planning and the values held by diverse stakeholders on Jekyll Island, S.C.
• Collaborating with the Georgia Department of Natural Resources to assess stakeholders' expectations and preferences for trout fishing.
CANADA
UNITED STATES
MINNESOTA
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Climate Science

The effects of projected climate trends on fish and wildlife populations and habitats are a major concern of natural resource managers. CRU scientists work with cooperators to better understand potential implications and reduce uncertainty so that managers can better evaluate future scenarios and management options.

The California Unit is assessing restoration efforts and climate change on the abundance of the Chinook salmon population in Redwood Creek, California.

The Oregon Unit is addressing the priority goals established in "Rising to the Urgent Challenge" developed by the USFWS to establish their strategic climate change plan to assist managers with the development of adaptation and planning strategies in coastal areas.

The Utah Unit is leading research on whole-lake warming in the Arctic to better understand the sensitivity of lakes to changing conditions.

The Alaska Unit is—

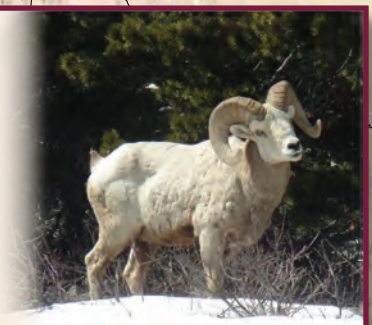
- Evaluating the effects of climate on available forage for moose and caribou, as modified by snow cover and fire regimes.
- Investigating the effects of large-scale climate patterns on caribou.
- Developing an Alaska-based research framework for migratory waterfowl.
- Developing the Integrated Ecosystem Model that integrates disturbance, permafrost, hydrology, and vegetation in Alaska and northwest Canada.

The Montana Fishery Unit is investigating how changes in climate and other factors have influenced the distributions of native and nonnative fishes throughout time. This information is needed to help guide future restoration and management efforts in Yellowstone National Park.

The Colorado Unit is delineating population boundaries based on the movement and space use of animals to aid in the effective management of wildlife populations in the North Atlantic and Bering Sea.

The New Mexico Unit is—

- Assessing how drought affects cutthroat trout and wildlife species in the southwestern United States.
- Evaluating adaptive capacity of desert bighorn sheep to climate change by identifying genetic links to climate adaptations in native and reintroduced populations.



The Wisconsin Fishery Unit is exploring how climate affects inland recreational fisheries, an economically viable sport fishing industry.

The Kansas Unit is developing a human-landscape model that incorporates the linkages among atmospheric, terrestrial, aquatic, and social processes to predict the potential impact of climate variability, climate change, land use, and human activity on water resources.

The Vermont Unit is assessing the role of climate in forest ecosystem health and function through a combination of monitoring, experiments, and modeling. The researchers will focus on American black bear, moose, and white-tailed deer.

The Missouri Unit is—

- Developing measures of vulnerability to climate change and disturbance of aquatic communities in national parks within the Heartland Network.
- Quantifying the effects of changing climate conditions on wetland plant production in the playa wetlands.
- Engaging resource managers to identify science needs for long-term management of floodplain conservation lands.

The Louisiana Unit is—

- Researching coastal wetland-dependent wildlife associated with sea level rise.
- Investigating the occurrence of submerged aquatic vegetation communities within the northern Gulf of Mexico.
- Exploring long-term accretion rates in managed and unmanaged coastal marshes in southwestern Louisiana.

The South Carolina Unit is exploring historical data from surveys in Kansas to better understand the effects of weather and land-use change on lesser prairie-chickens, northern bobwhites, and ring-necked pheasants.

Universal Transverse Mercator projection, zone 14

Advanced Technologies

Advanced technologies include development and adaptation of new technologies and tools that increase effectiveness, efficiency, safety, accuracy, geographic extent, or timeliness of gathering data, dissemination, analysis, and interpretation of natural resource phenomena. It also includes development of new tools that assist natural resource managers in decision making and adaptive management.

The Washington Unit is using satellite imagery to develop a new technique for documenting snow geese on Wrangel Island.

The Oregon Unit is using remote cameras and acoustic recorders to monitor Leach's storm-petrel.

The Utah Unit is using geospatial data layers and the internet to monitor wildlife habitat across Utah.

The Arizona Unit is—

- Assessing modified electrofishing devices for surveying fish habitat in desert streams.
- Developing low-cost, high-definition videography for documenting underwater plants and animals.
- Using high-definition videography to educate the public on cryptic desert fishes of southern Nevada and the Death Valley region.
- Developing a website and database that will accompany the book "Standard Methods for Sampling North American Freshwater Fishes."

The Hawaii Unit is quantifying parrotfish grazing activity using computer-aided image analysis.

The Minnesota Unit is exploring the use of acoustic monitors as a method to assess the effects of wind energy development on wildlife.

The Wisconsin Fishery Unit is using aerial survey data to develop spatially explicit distribution models for waterbirds on Lake Michigan.

The South Carolina Unit is collaborating with the Natural Resources Conservation Service to evaluate a new tool to monitor the effectiveness of and inform farm bill incentive programs related to avian species of conservation concern in South Carolina.

The Mississippi Unit is assessing the utility of the remote sensing platform and a multi-camera payload to provide visible, near-infrared, and thermal data for USGS earth science missions.

The Florida Unit is developing models that help determine key targets for water management in the Greater Everglades Ecosystem.

Where Are They Now?

One of the greatest legacies of the CRU program is the placement of our students in natural resource agencies and organizations. Key to the concept of a unit brand is the notion that a hiring official will recognize added value in an applicant who received their graduate education in a CRU. The sheer volume of unit graduates that staff agencies and the proportion of those who are leaders is a tribute to the value of a CRU education.

A pillar of the CRU mission is to develop the workforce of the future through graduate education. This graphic shows where some of our recent graduates have settled into professional positions with State, Federal, university, and nongovernmental positions.

Unit	University	Nongovernmental, private,other	State government	Federal Government
Alabama	4	3	5	0
Alaska	0	3	5	6
Arkansas	10	6	10	9
Arizona	6	4	2	7
California	3	8	3	0
Colorado	9	6	2	4
Georgia	1	0	1	0
Idaho	3	3	11	2
Iowa	4	7	4	1
Kansas	13	9	6	12
Louisiana	4	7	3	0
Maine	9	5	7	1
Massachusetts	6	10	12	3
Minnesota	5	5	3	4
Mississippi	5	7	19	3
Missouri	4	6	9	2
Montana-Fishery	2	2	8	5
Montana-Wildlife	4	4	2	1
Nebraska	12	17	13	2
New Mexico	2	1	11	3
New York	4	0	2	0
North Carolina	8	4	5	6
Oklahoma	6	3	6	6
Oregon	7	6	3	3
Pennsylvania	8	6	5	2
South Carolina	3	6	2	2
South Dakota	2	3	9	5
Tennessee-Fishery	3	1	8	2
Texas	3	14	5	2
Utah	3	5	6	3
Vermont	2	3	1	1
Virginia	7	4	1	1
Washington	4	3	4	3
West Virginia	5	4	4	8
Wisconsin-Fishery	0	1	5	7
Wisconsin-Wildlife	5	3	2	3
Wyoming	10	2	10	4
Total*	**186**	**181**	**214**	**123**

*Not all Units are listed. Data range from 2012 to 2018.

Accolades

Unit scientists and their students received approximately 82 awards in 2018 from universities, agencies, and societies with recognition at the local, national, and international levels. Highlights include the following:

- Peter R. Stettenheim Service Award, American Ornithological Society
  Anna Chalfoun, Wyoming Unit
- Outstanding Book Award, Texas Chapter of The Wildlife Society
  Clint Boal, Texas Unit and
  David Haukos, Kansas Unit
- Early Career Award, American Fisheries Society Genetics Section
  Wes Larson, Wisconsin Fishery Unit
- Best Poster, University of Missouri
  Craig Paukert and Corey Dunn, Missouri Unit
- American Fisheries Society Fellow, American Fisheries Society
  Reynaldo Patiño, Texas Unit

Barry Grand (right), accepting a 30-year service award from John Organ.

Texas Tech University, Department of Natural Resources Management.

Dr. Clint Boal and Dr. Blake Grisham at the 2018 Texas Chapter of The Wildlife Society meeting in Dallas, Texas. Dr. Boal was awarded the Outstanding Publication Award - Book for "Ecology and Conservation of Lesser Prairie-Chickens" along with Dr. David Haukos (not pictured).

- Robert L. Kendall Best Paper in Transactions of the American Fisheries Society
  Brian Irwin, Georgia Unit and
  Tyler Wagner, Pennsylvania Unit
- Edward D. Bellis Award, Pennsylvania State University Ecology Program
  Tyler Wagner, Pennsylvania Unit
- Gold Chalk Award for Outstanding Mentoring and Teaching, University of Missouri
  Craig Paukert, Missouri Unit
- Equal Opportunity Section Award, American Fisheries Society
  Amanda Rosenberger, Tennessee Unit

Professional Services

Unit scientists held approximately 427 professional service positions (scientific society officers, technical committees, working groups, panels, and so forth) and served in 101 editorial positions in fiscal year 2018.

427
professional service positions

101
editorial positions

2018 North American Wildlife and Natural Resources Conference

Building Resiliency Workshop

The CRU program co-sponsored a workshop at the 2018 North American Wildlife and Natural Resources Conference with the Association of Fish and Wildlife Agencies, the American Fisheries Society, The Wildlife Society, and the Wildlife Management Institute titled "Bridging Science and Management: Building Resiliency to Ensure Relevance." The workshop built upon the 2017 workshop, "Bridging Science and Management: Maintaining Relevancy Through Organization Transformation and Professional Development."

The 2018 workshop was the third in a series of successful workshops that focused on the dynamic changes in social and environmental landscapes currently facing wildlife agencies and wildlife science, and how agencies can build resiliency to address these challenges. To be resilient, the institution of wildlife conservation must be willing to adapt progressively while retaining the core values and beliefs that characterize North American conservation. With many agencies and universities facing reduced capacities, embracing new challenges, maintaining core responsibilities, and striving to be in the forefront of science applications become a daunting challenge.

National Cooperators' Coalition Update

The National Cooperators Coalition (NCC) comprises the non-Federal cooperators in the Cooperative Fish and Wildlife Research Units program. The NCC is chaired by John Kennedy, Deputy Director of the Wyoming Game and Fish Department, and is led by a Steering Committee with the following members: Jonathan Mawdsley (Association of Fish and Wildlife Agencies [AFWA]), Chad Bishop (University of Montana and National Association of University Fish and Wildlife Programs [NAUFWP]), Steve Williams (Wildlife Management Institute), Keith Norris (The Wildlife Society), and Lowell Baier (Boone and Crockett Club).

The NCC, under the leadership of Chairman Kennedy, focused its efforts in 2018 on gaining congressional support for full funding of the CRUs. Chairman Kennedy along with Lowell Baier engaged with key Congressional leaders during a spring visit to the Nation's capital to raise awareness and build support for the CRUs. University leaders, through communications from NAUFWP and the Association for Public Land Grant Universities, have been encouraged to raise awareness among their State leaders of the need to fill vacant CRU positions in their States. The Boone and Crockett Club, through efforts of Lowell Baier, James Cummins, and David Anderson, has been instrumental in building support for the CRUs. The AFWA has worked diligently in encouraging the support of all State fish and wildlife agency directors to urge Congress to fully fund the CRUs. This coordinated effort by NCC can be beneficial in addressing the record number of vacant scientist positions that currently exist in the program. Their efforts were reflected in House and Senate marks on the fiscal year 2019 budget that proposed increases for the CRU program.

The CRU leadership team met with Dr. Benjamin Tuggle and his U.S. Fish and Wildlife Service Science Applications leadership team in Kansas City, Missouri, during January 2018 to strengthen this important collaboration with strategic initiatives designed to provide benefit to the Nation's natural resources and the people who enjoy them.

The Cooperative Fish and Wildlife Research Units Program is proud to serve its cooperators

ALABAMA
Auburn University
Alabama Department of Conservation and Natural Resources

ALASKA
University of Alaska Fairbanks
Alaska Department of Fish and Game

ARIZONA
University of Arizona
Arizona Game and Fish Department

ARKANSAS
University of Arkansas
Arkansas Game and Fish Commission

CALIFORNIA
Humboldt State University
California Department of Fish and Wildlife

COLORADO
Colorado State University
Colorado Parks and Wildlife

FLORIDA
University of Florida
Florida Fish and Wildlife Conservation Commission

GEORGIA
University of Georgia
Georgia Department of Natural Resources

HAWAI'I FISHERY UNIT
University of Hawai'i
Hawai'i Department of Land and Natural Resources

IDAHO
University of Idaho
Idaho Department of Fish and Game

IOWA
Iowa State University
Iowa Department of Natural Resources

KANSAS
Kansas State University
Kansas Department of Wildlife, Parks and Tourism

LOUISIANA
Louisiana State University
Louisiana Department of Wildlife and Fisheries

MAINE
University of Maine
Maine Department of Inland Fisheries and Wildlife

MARYLAND
University of Maryland, Eastern Shore
Maryland Department of Natural Resources

MASSACHUSETTS
University of Massachusetts
Massachusetts Division of Fisheries and Wildlife
Massachusetts Division of Marine Fisheries

MINNESOTA
University of Minnesota
Minnesota Department of Natural Resources

MISSISSIPPI
Mississippi State University
Mississippi Department of Wildlife, Fisheries, and Parks

MISSOURI
University of Missouri Columbia
Missouri Department of Conservation

MONTANA FISHERY UNIT
Montana State University
Montana Department of Fish, Wildlife and Parks

MONTANA WILDLIFE UNIT
University of Montana
Montana Department of Fish, Wildlife and Parks

NEBRASKA
University of Nebraska Lincoln
Nebraska Game and Parks Commission

NEW MEXICO
New Mexico State University
New Mexico Department of Game and Fish

NEW YORK
Cornell University
New York State Department of Environmental Conservation

NORTH CAROLINA
North Carolina State University
North Carolina Wildlife Resources Commission

OKLAHOMA
Oklahoma State University
Oklahoma Department of Wildlife Conservation

OREGON
Oregon State University
Oregon Department of Fish and Wildlife

PENNSYLVANIA
Pennsylvania State University
Pennsylvania Fish and Boat Commission
Pennsylvania Game Commission

SOUTH CAROLINA
Clemson University
South Carolina Department of Natural Resources

SOUTH DAKOTA
South Dakota State University
South Dakota Department of Game, Fish, and Parks

TENNESSEE FISHERY UNIT
Tennessee Technological University
Tennessee Wildlife Resources Agency

TEXAS
Texas Tech University
Texas Parks and Wildlife Department

UTAH
Utah State University
Utah Division of Wildlife Resources

VERMONT
University of Vermont
Vermont Fish and Wildlife Department

VIRGINIA
Virginia Polytechnic Institute and State University
Virginia Department of Game and Inland Fisheries

WASHINGTON
University of Washington
Washington State University
Washington State Department of Ecology
Washington Department of Fish and Wildlife
Washington State Department of Natural Resources

WEST VIRGINIA
West Virginia University
West Virginia Division of Natural Resources

WISCONSIN FISHERY UNIT
University of Wisconsin Stevens Point
Wisconsin Department of Natural Resources

WISCONSIN WILDLIFE UNIT
University of Wisconsin Madison
Wisconsin Department of Natural Resources

WYOMING
University of Wyoming
Wyoming Game and Fish Department

List of Species

Common name	Scientific name
alewife	*Alosa pseudoharengus*
alfalfa	*Medicago sativa*
American black bear	*Ursus americanus*
American eel	*Anguilla rostrata*
Arctic grayling	*Thymallus arcticus*
Asian tapeworm	*Bothriocephalus acheilognathi*
Atlantic salmon	*Salmo salar*
band-tailed pigeon	*Patagioenas fasciata*
bighead carp	*Hypophthalmichthys nobilis*
bighorn sheep	*Ovis canadensis*
black rail	*Laterallus jamaicensis*
black rosy-finch	*Leucosticte atrata*
black-footed ferret	*Mustela nigripes*
black-tailed prairie dog	*Cynomys ludovicianus*
blue catfish	*Ictalurus furcatus*
bluehead sucker	*Catostomus discobolus*
bobcat	*Lynx rufus*
bonytail chub	*Gila elegans*
brook floater (type of mussel)	*Alasmidonta varicosa*
brown trout	*Salmo trutta*
bull trout	*Salvelinus confluentus*
burbot	*Lota lota*
Burmese python	*Python bivittatus*
burrowing owl	*Athene cunicularia*
Canada goose	*Branta canadensis*
Canada lynx	*Lynx canadensis*
candy darter	*Etheostoma osburni*
caribou	*Rangifer tarandus*
Carolina madtom	*Noturus furiosus*
catfish	*Siluriformes*
cattle	*Bos taurus*
cerulean warbler	*Setophaga cerulea*
channel catfish	*Ictalurus punctatus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chiricahua leopard frog	*Lithobates chiricahuensis*
cisco	*Coregonus artedi*
coastal cutthroat trout	*Oncorhynchus clarkii clarkii*
coho salmon	*Oncorhynchus kisutch*
Colorado pikeminnow	*Ptychocheilus lucius*
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*
Columbia spotted frog	*Rana luteiventris*
common carp	*Cyprinus carpio*
common eider	*Somateria mollissima*
common loon	*Gavia immer*
cougar or mountain lion	*Puma concolor*

Common name	Scientific name
coyote	*Canis latrans*
cutthroat trout	*Oncorhynchus clarkii*
desert bighorn sheep	*Ovis canadensis nelsoni*
diamond darter	*Crystallaria cincotta*
eastern spotted skunk	*Spilogale putorius*
eastern wild turkey	*Meleagris gallopavo silvestris*
elk	*Cervus canadensis*
Eurasian watermilfoil	*Myriophyllum spicatum*
feral burro	*Equus asinus*
feral cat	*Felis catus*
fisher	*Pekania pennanti*
flathead catfish	*Pylodictis olivaris*
giant kangaroo rat	*Dipodomys ingens*
golden alga	*Prymnesium parvum*
golden eagle	*Aquila chrysaetos*
golden-winged warbler	*Vermivora chrysoptera*
gopher tortoise	*Gopherus polyphemus*
grass carp	*Ctenopharyngodon idella*
gray wolf	*Canis lupus*
greater sage-grouse	*Centrocercus urophasianus*
green sunfish	*Lepomis cyanellus*
grizzly bear	*Ursus arctos*
Gunnison sage-grouse	*Centrocercus minimus*
humpback chub	*Gila cypha*
river herring	*Alosa* spp.
Key Largo woodrat	*Neotoma floridana smalli*
king eider	*Somateria spectabilis*
kokanee	*Oncorhynchus nerka*
lake trout	*Salvelinus namaycush*
largemouth bass	*Micropterus salmoides*
Leach's storm-petrel	*Oceanodroma leucorhoa*
lesser prairie-chicken	*Tympanuchus pallidicinctus*
lesser scaup	*Aythya affinis*
loggerhead sea turtle	*Caretta caretta*
longnose darter	*Percina nasuta*
Louisiana waterthrush	*Parkesia motacilla*
marbled murrelet	*Brachyramphus marmoratus*
marsh rabbit	*Sylvilagus palustris*
Mexican wolf	*Canis lupus baileyi*
moose	*Alces alces*
mosquitofish	*Gambusia affinis*
mottled sculpin	*Cottus bairdii*
mountain sucker	*Catostomus platyrhynchus*
mountain whitefish	*Prosopium williamsoni*
mule deer	*Odocoileus hemionus*

List of Species—Continued

Common name	Scientific name
northern bobwhite	*Colinus virginianus*
northern Idaho ground squirrel	*Urocitellus brunneus brunneus*
northern leopard frog	*Lithobates pipiens*
northern red-bellied cooter	*Pseudemys rubriventris*
northern redbelly dace	*Chrosomus eos*
pallid sturgeon	*Scaphirhynchus albus*
pearl dace	*Margariscus margarita*
ring-necked pheasant	*Phasianus colchicus*
phragmites	*Phragmites australis*
plains topminnow	*Fundulus sciadicus*
prairie dog	*Cynomys* spp.
pumas	*Puma concolor*
purple cat's paw pearlymussel	*Epioblasma obliquata obliquata*
rainbow trout or steelhead	*Oncorhynchus mykiss*
razorback sucker	*Xyrauchen texanus*
red shiner	*Cyprinella lutrensis*
redwood	*Sequoia sempervirens*
regal fritillary	*Speyeria idalia*
sandhill crane	*Grus canadensis*
sea lamprey	*Petromyzon marinus*
shovelnose sturgeon	*Scaphirhynchus platorynchus*
sicklefin redhorse	*Moxostoma* sp.
silver carp	*Hypophthalmichthys molitrix*
smallmouth bass	*Micropterus dolomieu*
Smith's longspur	*Calcarius pictus*
snow goose	*Chen caerulescens*
snowy plover	*Charadrius nivosus*
snuffbox	*Epioblasma triquetra*
speckled dace	*Rhinichthys osculus*
stonecat	*Noturus flavus*
striped bass	*Morone saxatilis*
swift fox	*Vulpes velox*
tegu	*Tupinambis* spp.
Topeka shiner	*Notropis topeka*
Townsend's big-eared bat	*Corynorhinus townsendii*
walleye	*Sander vitreus*
westslope cutthroat trout	*Oncorhynchus clarkii lewisi*
white sucker	*Catostomus commersonii*
white-tailed deer	*Odocoileus virginianus*
whooping crane	*Grus americana*
woodrat	*Neotoma floridana smalli*
Yaqui catfish	*Ictalurus pricei*
yellow perch	*Perca flavescens*
yellow-billed loon	*Gavia adamsii*
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*

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