COOPERATIVE RESEARCH UNITS

YEAR IN REVIEW

2012

In Fiscal Year (FY) 2012, the Cooperative Research Units (CRU) Program operated with an enacted budget of $18.8 million, which represented a net decrease of $0.3 million from the enacted budget of $19.1 million in FY 2011 and a cumulative net decrease of $0.5 million from FY 2010. At present, CRU is operating under a continuing resolution with a budget of $18.4 million through the end of March 2013. The President's proposed budget for FY 2014 for CRU is also currently under formulation and has not been released to the public.

As detailed below, CRU continued in FY 2012 to invest significant funding in Units for staffing, operational support, safety equipment and training, and research vehicles. Start-up funds were provided to new Unit scientists and included incentive funds to work with cooperators. Collectively, the strong budget based investments in new staff, along with the multi-year investments in new equipment, will enable Units to address the expanding needs of state and federal cooperators in the future.

STAFFING

CRU's intensive efforts to rebuild science capacity in 2010 and 2011 were followed in FY 2012 with new hiring efforts initiated for assistant unit leader positions at the Arizona, Utah, and Wisconsin-Fish Units. In January 2013, Dan Isermann was selected as the assistant unit leader at Wisconsin-Fish. Hiring actions for the other two assistant unit leader positions are ongoing. In addition, two assistant unit leaders were promoted to the position of unit leader at the Utah and Wisconsin-Fisheries Units.

The cooperative and strategic effort to rebuild science capacity beginning in FY 2010—when the program received a near $2 million funding increase—continued through FY 2012, and reduced the number of program vacancies to 11, from 26 vacancies in FY 2007. However, an additional four scientist positions were vacated in FY 2012 through retirements and other attrition, thus the total number of vacancies is 14 positions at present. Filling scientist positions remains a high priority strategic goal that is influenced strongly by federal funding and the certainty of funding from year to year. Further analysis of long term trends in vacancies and program funding levels is provided on page 3.

CRU program Chief Dr. Ken Williams retired on March 1, 2013. Dr. Williams served as program Chief for 14 years and will join the Wildlife Society as Executive Director starting in March 2013. Dr. Williams will remain an important cooperator and supporter of the CRU program.

COOPERATOR CONTRIBUTIONS FOR SCIENCE

In this year's review, we provide a long term analysis of the reimbursable funding trends from core CRU partners. By organic design, 100 percent of CRU funding for research is cooperator derived. This long standing funding model ensures that research conducted by the Units addresses the needs of our cooperators and partners. New internal efforts initiated in FY 2011 enabled CRU to more accurately document contributions of state cooperators. The collective funding from state and federal cooperators, combined with the in-kind contributions of host universities, drives a substantial portfolio of graduate student oriented research and supports over 500 graduate students each year.

CONTINUED ON PAGE 2

Rabbit Pond, on Nahmakanta Public Reserved Land, Maine.

YEAR IN REVIEW

CONTINUED

LUKE GROFF/MAINE UNIT

COMMITMENT TO SAFETY

The safety of CRU program staff—and that of the students and employees they supervise—remains our highest priority. CRU continued a commitment to safety in FY 2012 by funding over $200,000 of safety needs identified by the Units. Funds were provided to purchase new equipment and supplies and to cover costs for required safety training. In addition, the CRU program completed development and implementation of a new program-wide online safety system during FY 2012. The new system gives CRU unprecedented capabilities for documenting and tracking safety training compliance and for identifying training gaps across the program.

The system has provided invaluable data for safety budget planning at the individual Unit and national program levels, and has resulted in the creation of over 850 individual Job Hazard Analyses (JHAs) for our federal scientists and the staff and students they supervise. Notable functionality of the system includes: Generating individual, activity-based JHAs with required safety training included as controls; Capturing safety training records; Generating summary compliance reports for each Unit and the national program; and Documenting safety inspections conducted by our host universities and USGS specialized programs. The system provides direct utility and benefit for CRU's research scientists and resolves uncertainty regarding training needed for various activities and where necessary training can be found.

NATIONAL CONSERVATION LEADERSHIP INSTITUTE

The National Conservation Leadership Institute (NCLI) is an experiential training approach that is highly regarded in the state and federal natural resource management community. In FY 2012, CRU Deputy Chief Kevin Whalen was selected to join the seventh NCLI cohort. This important leadership training program is closely aligned with the training and education mission of CRU. CRU has put plans in place to nominate at least one Unit scientist each year for consideration for NCLI, and will continue to support the program into the future.

FUNDING OVERVIEW

CRU's organic research business model is a reimbursable funding model using both federal and state sources. In addition, CRU receives an annual line item appropriation for salaries and operating expenses. Legislative authorities developed over time enable CRU to accept federal research funding from both Department of the Interior (DOI) and non-DOI sources.

On average, cooperating states invest $12 million for research program-wide and federal entities fund about $18 million. Most federal funding is from DOI sources ($13 million per year), including the U.S. Geological Survey (USGS) ($7.4 million per year) and the U.S. Fish and Wildlife Service (USFWS) ($2.5 million per year) as top sponsors. Within the USGS, $1.7 million per year is provided through collaborations with Science Centers, and nearly $1 million per year is received through the USGS-FWS Science Support Partnership focused on priority research needs of the USFWS.

CRU also conducts research for a host of other federal departments and bureaus, including the U.S. Departments of Agriculture, Commerce, Defense, and Energy, and independent agencies including the U.S. Environmental Protection Agency. These agencies and organizations value and use the CRU program to help address their science needs which often match those of the states and DOI bureaus. The synergy of needs and the supporting reimbursable funding model provide opportunities for fully funding collaborative projects to address research priorities of interest to all entities involved.

The cumulative total of funding from state, federal, and non-governmental conservation organizations is what makes the CRU program so successful. The addition of reimbursable funding to the appropriated funding for salary and operations produces an effective budget for CRU of about $48 million per year. This is a minimum estimate of the effective program budget; it does not include the extensive in-kind support of university cooperators for administrative assistance, facilities, equipment, and commitment to reduced overhead to promote research.

Fund Source	2008	2009	2010	2011	2012	Yearly Average
Reimbursable funding						
Federal	$14.8	$15.2	$19.5	$21.9	$17.6	$17.8
DOI	$9.4	$9.0	$14.2	$17.1	$13.1	$12.6
Non-DOI	$5.4	$6.2	$5.3	$4.8	$4.5	$5.2
State	$9.1	$11.0	$12.5	$15.4	$11.8	$12.0
Total Reimbursable	$23.9	$26.2	$32.0	$37.3	$29.4	$29.8
USGS Appropriated	$16.2	$16.9	$19.3	$19.1	$18.8	$18.1
Total program funding (in millions)	$40.1	$43.2	$51.3	$56.4	$48.2	$47.8

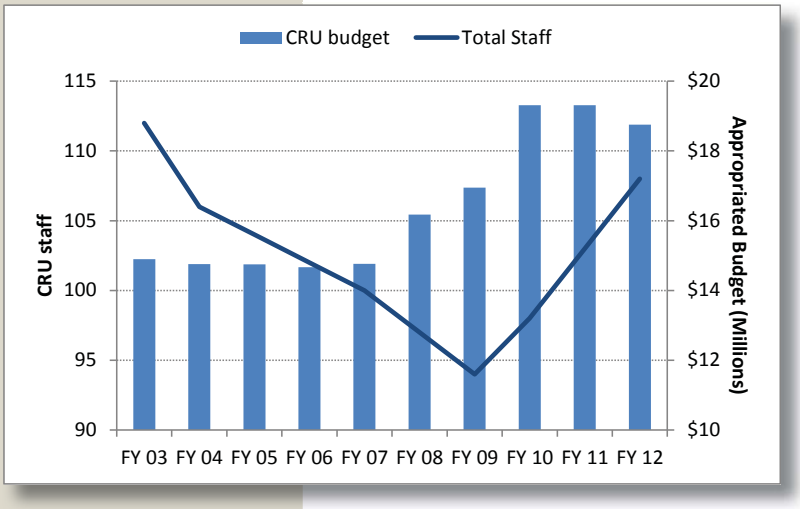
Program funding, 2008–2012: Reimbursable research funding sources by major category, state reimbursable funding, and USGS appropriated base funding.

CRU STAFFING AND BUDGET TRENDS

CRU typically invests about 90 percent of its appropriated budget in salary and personnel costs, maintaining a small proportion of budget for operations and discretionary spending focused on equipment and safety. Thus, changes in federal appropriations over time significantly affect CRU's ability to fill vacancies. We present below a long-term analysis of funding and hiring trends to illustrate the investments and commitments to maintaining science capacity in the program.

From FY 2003 through FY 2009, CRU staffing levels dropped steadily even though funding levels were nearly constant. New hires of less than or equal to one scientist per year were insufficient to offset the loss of between two and six scientists per year. Budget increases between FY 2008 and FY 2010 (through FY 2011) were immediately invested to hire scientists. During this time new hires were exceeding losses and total staff numbers began to rebuild, resulting in a marked increase in CRU staff levels between FY 2009 and FY 2012.

The total number of vacancies program-wide dropped to a 10-year low of 11 positions in FY 2011. However, the inexorable loss of scientist positions due largely to retirements continues to erode gains achieved in rebuilding science capacity. In FY 2013, currently three positions are advertised and one other vacancy has been filled which is expected to keep the vacancy total near 11 positions. Significant federal budget uncertainty exists at the time of this writing. The FY 2013 budget of $18.4 million provided to CRU for the continuing resolution will enable the program to backfill additional selected vacancies when they occur, assuming this funding level is extended through the remaining portion of FY 2013.



DAVID DESLAURIERS/SOUTH DAKOTA UNIT

Laura Heironimus, a master's student at the South Dakota Unit, works with the federally endangered pallid sturgeon. Her research is focused on the early life history and bioenergetics of pallid sturgeon.

CLINT BOAL/TEXAS UNIT

Clint Boal, assistant unit leader of the Texas Unit, with a bridled quail dove in the British Virgin Islands, where he has been conducting a long-term study since 2003 on neotropical bird migration and resident bird ecology in the context of weather and climate over the western Atlantic Ocean.

MARSHA MATHER/KANSAS UNIT

Zach Peterson and Martha Mather tag a blue catfish caught during the Blue Catfish Tagathon conducted by the Kansas Unit and the Kansas Department of Wildlife, Parks, and Tourism during summer 2012.

MIKE QUIST / IDAHO UNIT

Carson Watkins, Idaho Unit master's student, with a rainbow trout from the Kootenai River, Idaho, where that Unit is conducting research in cooperation with the Idaho Department of Fish and Game, Montana Department of Fish, Wildlife, and Parks, and the Kootenai Tribe of Idaho.

FIRST FIVE CRU STUDENTS TAKE STRUCTURED DECISION MAKING COURSE THROUGH OREGON STATE UNIVERSITY PARTNERSHIP

CRU and Oregon State University established a partnership to offer a graduate-level, distance learning course in Structured Decision Making (SDM), with the first class session held in the 2012 fall quarter. Reviews received from the five CRU student participants were positive and nominations have been received for students to participate in the next session to be held in 2013. Two sessions of the class will be offered each year, and up to five CRU students, nominated by their federal scientist advisor, will be invited to participate in each class. The partnership provides mutual benefits to the CRU program and Oregon State, enabling CRU scientists and students program-wide to access (for credit) an advanced course in decision analysis while enhancing Oregon State's distance learning program. CRU's partnership with Oregon State complements other such partnerships that Unit scientists have developed to advance new approaches to graduate education and training, and to make courses at individual universities available to CRU students program-wide.

ALASKA UNIT SCIENTIST NAMED FELLOW OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A. David McGuire, assistant leader of ecology at the Alaska Cooperative Fish and Wildlife Research Unit and Professor of Ecology at the University of Alaska Fairbanks' Institute of Arctic Biology and Department of Biology and Wildlife, was named a Fellow of the American Association for the Advancement of Science, the world's largest general scientific society and publisher of the journal Science. McGuire was recognized for distinguished contributions to the field of terrestrial ecology, particularly for his work on the role of arctic and boreal terrestrial ecosystems in the climate system. Since 1990, McGuire's research has focused on developing a terrestrial ecosystem model that describes carbon and nitrogen flow in terrestrial ecosystems to forecast how Alaska's landscapes might change in response to climate warming. Climate change throughout the circumpolar arctic has the potential to affect ecosystems and the services they provide—including food, fiber and recreation—to the people of Alaska and the nation.

U.S. GEOLOGICAL SURVEY

A. David McGuire (right) was named a Fellow of the American Association for the Advancement of Science.

Dave Haukos of the Kansas Unit led the Northern Pintail Action Group at the Sixth North American Duck Symposium.

THE SIXTH NORTH AMERICAN DUCK SYMPOSIUM

and Ecology and Management of North American Waterfowl Conference were held in Memphis, Tennessee, January 27–31, 2013. The meeting attracted 450 scientists and students from around the globe and included 220 invited and contributed talks and 85 posters. The CRU Program was well represented with eight scientists contributing to the technical program, four of whom also had instrumental roles in the conference: Dave Haukos (Kansas) organized and led a well-attended meeting of the Northern Pintail Action Group; Al Afton (Louisiana) served on the Scientific Program Committee and chaired the Robert Todd Eberhardt Memorial Award Committee; Lisa Webb (Missouri) served on the Scientific Program Committee and co-chaired the Poster Session Committee; and Joshua Stafford (South Dakota) chaired the Student Awards Committee, presented a plenary talk in the opening session of the conference on "Spring Habitat Use and Selection by Waterfowl." Information is available at www.northamericanducksymposium.com and the next North American Duck Symposium will be held in Delaware in 2016.

Students at the Wyoming Unit release a captured moose after fitting it with a GPS collar as part of a study of declining calf recruitment of Shiras moose in western Wyoming.

PROGRAM PERFORMANCE

MARK GOCKE/WYOMING GAME AND FISH DEPARTMENT

ACHIEVING THE UNIT MISSION

In FY 2012, Unit scientists and cooperators advanced the mission of the CRU program through joint research, education, technical assistance, and science support. Unit scientists conducted 862 projects to meet the research needs of their state and federal partners. Unit scientists and their students remained actively engaged in service to professional societies delivering 840 presentations. Many of these presentations are delivered in direct response to requests from the scientific and management communities. CRU's service to university cooperators continued to be strong, with 74 academic classes taught in FY 2012 and 33 workshops and short courses delivered to partners and cooperators.

Each year, over 500 students engage in graduate education and training in natural resources conservation through the CRU program. About 15 percent of these students graduate each year and enter the natural resources management workforce as employees of state and federal agencies, non-governmental organizations, and universities. Eighty-three graduate degrees were awarded to Unit students in FY 2012, which is consistent with the long-term trend.

PRODUCTIVITY SUMMARY

PEER-REVIEWED PUBLICATIONS	**358**
INVITED SEMINARS	**69**
WORKSHOPS AND SHORT COURSES	**33**
RESEARCH PROJECTS	**862**
PAPERS PRESENTED	**840**
ACADEMIC COURSES TAUGHT	**74**
NUMBER OF STUDENTS	**555**
MASTER'S DEGREES AWARDED	**60**
DOCTORAL DEGREES AWARDED	**23**

HAL SCHRAMM/MISSISSIPPI UNIT

Mississippi Unit students Nathan Kuntz and Jason Herrala with endangered pallid sturgeon (left) and threatened shovelnose sturgeon (right) implanted with sonic tags to describe the fishes movement and habitat selection in the lower Mississippi River.

LUKE GROFF/MAINE UNIT

Andrew McIntyre and Lee Hecker conduct visual encounter surveys for pool breeding amphibian egg masses and larvae at Loon Pond in Maine's Nahmakanta Public Reserved Land in support of research at the Maine Unit to assess alternative breeding habitats by pool-breeding amphibians in high elevation montane landscapes.

STRATEGIC DIRECTIONS—

USING SATELLITE AND GPS TAGS TO ADDRESS LARGE-SCALE, TRANSBOUNDARY ISSUES

New developments in advanced technologies often lead to significant discoveries and new information to inform fish and wildlife management. Unit scientists are at the cutting edge of the applications of new technologies to advanced science. In this report, we feature the application of new satellite and global positional systems (GPS) technologies by Unit scientists throughout the program to close gaps in knowledge on landscape level wildlife science and management.

COLORADO Mevin Hooten and his students are using satellite telemetry data to evaluate a variety of wildlife populations. Studies are underway on movement and behavior of an Alaskan population of northern fur seals; resource selection models for mountain lions on the front range of the Colorado Rocky Mountains; spatial ecology, movement and resource selection of Alaskan harbor seals; and the effect of landscape connectivity and corridors on reintroductions of large carnivores, i.e., mountain lions and lynx. In addition to these applied studies, Hooten and his students are developing new methods and techniques for analyzing satellite telemetry data.

IDAHO Courtney Conway is using satellite tags and geolocators on burrowing owls, a species of National Conservation Concern in the United States, to map the migratory behavior throughout its Canada to Mexico range. Conway hopes to identify where the owls go during the winter, migratory routes, and the timing and duration of their migratory movements.

KANSAS Dave Haukos is using satellite transmitters on mottled ducks of the upper Texas Gulf Coast to measure variation of movements, habitat selection, and home ranges for female mottled ducks across all biological periods. The locations obtained will also be used in a risk assessment for lead exposure by mottled ducks. Haukos is also starting a new project on lesser prairie-chickens in Kansas and Colorado to measure movements, habitat use, dispersal, and home range throughout the year.

MASSACHUSETTS Steve DeStefano is using GPS technology to study movement patterns, resource use, and human-wildlife interactions of a wide variety of wildlife, including moose, black bears, and gulls. Results show that moose range across three states (Massachusetts, New Hampshire, and Vermont), and that gulls range widely up and down the eastern seaboard, from maritime Canada to Florida.

MASSACHUSETTS Researchers are studying the movement of American oystercatchers in relation to proposed off shore wind turbines in Nantucket Sound. Research plans are in place to attach satellite tags to five American oystercatchers to describe foraging and migratory movements relative to the site of the proposed Cape Wind turbines in Nantucket Sound.

MINNESOTA David Andersen is using satellite GPS tags on eastern population sandhill cranes to describe migratory movements, staging behavior, wintering areas, and to a lesser extent, breeding distribution.

TECHNOLOGY TRANSFER—STATISTICAL ANALYSIS TRAINING AVAILABLE

Based on demand and a recognized training need, Thomas Edwards of the Utah Unit has developed a set of six short courses on analytical methods for biologists. The classes are built around **R**, a free software program that is increasingly being used for data management, graphics, and statistical analysis. Courses run from one to five days in length, and are delivered as a set of modules. The modules are designed for sequential delivery, but individual modules can be extracted from each course for standalone delivery. The first course, **baseR**, focuses on data management. The second course, **graphR**, teaches how to build high resolution, publication quality graphs using **R**'s extensive graphical capabilities. The last four courses, **statR-1** through **statR-4**, describe and demonstrate descriptive statistics, analysis of variance based techniques, regression approaches, and categorical methods.

The courses are extremely popular and have gained some notoriety. Edwards recently held a three-day workshop for 34 biologists from the Utah Department of Wildlife Resources using **baseR** to demonstrate how to input, organize and manipulate data as well as performing data checking, new variable creation, data splitting for analysis, and constructing functions and looping procedures for commonly repeated analyses. The well-attended workshop is a great contemporary example of a Unit meeting our technical assistance mission in support of their cooperators. Additionally, the U.S. Fish and Wildlife Service's National Conservation Training Center (NCTC) has asked Edwards to develop (with NCTC support) **baseR** and **graphR** courses for online delivery to Department of the Interior biologists and partners. The first two courses will be recorded during spring 2013 and are scheduled for distribution in summer 2013. All courses will be available to Cooperative Research Units Program cooperators.

ADVANCED TECHNOLOGIES

The application of new satellite and GPS technologies is strongly consistent with CRU's recent strategic emphasis on fish and wildlife conservation, management and research at large, transboundary scales. Transboundary, landscape scale research is necessary to answer questions that cannot be adequately addressed in one state alone. Below, we present a list of taxa and questions Unit scientists are addressing using these new technologies – the list is extremely diverse and fascinating! Read below to learn more about the research and new methods being developed by our Units to address research needs of multiple cooperators at unprecedented geographic scales.

MISSOURI Lisa Webb is evaluating nonbreeding habitat selection of mallard hens based on GPS satellite transmitters. Preliminary results indicate mallards are selecting specific wetland habitat types during smaller regional movements of less than 30 kilometers and selecting areas with general aquatic habitats following longer migratory movements that are greater than 30 kilometers.

NEW MEXICO James Cain is using satellite transmitters to assess migratory routes (migratory eagles) and habitat selection (migratory and resident eagles) of golden eagles captured during the winter in southern New Mexico as part of a larger study on the potential impacts of wind energy development. Preliminary results indicate a wide distribution of eagles settling in the first summer (Montana, Wyoming, and Utah, and Alberta, Canada) for the 2012 breeding season, with all migratory eagles returning to southern New Mexico for the 2012-2013 winter.

NORTH CAROLINA Ted Simons will be putting satellite tags on American oystercatchers in spring 2013 to track the movement of breeding birds to wintering grounds. Cooperative mark-resight studies over the past 10 years have shown that birds breeding as far north as Massachusetts winter as far away as the Gulf Coast of Florida, but little is known about the timing and pattern of migratory movements.

OREGON Dan Roby is using satellite tags to track double-crested cormorants to determine where they spend the non-breeding season, and to gain a better understanding of what drives movements and site fidelity. This information is needed to determine where displaced cormorants are likely to reestablish nests.

PENNSYLVANIA Duane Diefenbach, Pennsylvania Unit, and Angela Fuller, New York Unit, are using satellite tags on female wild turkeys to monitor survival and harvest rates of 120 birds distributed across Pennsylvania and New York. The tags have proven invaluable for monitoring birds over wide distributions in remote areas.

UTAH Tom Edwards is currently conducting a large-scale evaluation of animal movement patterns over the greater Colorado Plateau ecoregion using satellite-based GPS telemetry. The research involves modeling the responses of three ungulate species (mule deer, bighorn sheep, and elk) to seasonal changes in plant phenology and snowpack dynamics using high temporal resolution satellite imagery. These models will be used to predict the movements, habitat use, and survival probabilities of their primary predator, mountain lions, across varying climatic zones and jurisdictional boundaries.

TRANSBOUNDARY MANAGEMENT AND CONSERVATION—LINKING LANDSCAPE LEVEL AND LARGE-SCALE DYNAMICS TO ECOLOGICAL MONITORING AND MANAGEMENT

Anchored by the efforts of scientists from the Georgia, Maine, and Pennsylvania Units, a new transboundary study will emphasize connections between fisheries monitoring and management decision-making across multiple scales. Current activities include collaborating with state management agencies across the eastern U.S. to compile a regional database on stream fish assemblages. The database will be used to evaluate management and conservation objectives related to detecting and describing changes in stream fish populations. For example, population dynamics of smallmouth bass are of management interest across a large geographic range. Increasing our understanding of trends in smallmouth bass abundance across various watersheds and states, will help managers consider local and regional management options as well as other potential influences that can span traditional jurisdictional boundaries such as flow and temperature. A transboundary approach is intended to improve the ability to make inferences over spatial and temporal scales. For instance, detecting temporal changes in survey data is relevant to state cooperators and other management agencies for several reasons: (1) management actions often have time-limited objectives; (2) populations often respond in complex ways to both natural and anthropogenic factors; and (3) knowledge of previous population dynamics can inform structured decision making processes by identifying critical system components. Synthesizing information from monitoring programs can provide a critical feedback loop for learning about system dynamics. However, the ability to achieve large-scale syntheses is not common within the spatial and temporal scope of most individual investigations. Collaborative efforts such as this will become increasingly important to more fully examine landscape level resource management.

RESEARCH HIGHLIGHTS

The research highlights presented below focus on a subset of the many issues in which Unit scientists are engaged across the nation in service to state and federal cooperators. The selected projects highlight CRU's work on waterfowl and science associated with commercially and recreationally important fisheries; research on wetland function and endangered species; new and innovative ways of improving the rigor of monitoring; and understanding and resolving critical questions related to the effect of forest management on bat and bird populations. CRU cooperator-focused research remains strongly geared toward solving real-world management problems, in addition to pushing the frontiers of science itself.

Lake Whitefish Genetics

Brian Sloss, Wisconsin–Fish Unit

BRIAN SLOSS/WISCONSIN-FISH UNIT

Since 2004, Wisconsin-Fish Unit Leader Brian Sloss has collaborated with the Wisconsin Department of Natural Resources, the Michigan Department of Natural Resources, and Chippewa-Ottawa Regional Authority—with the assistance of numerous commercial fishermen and funding from the Great Lakes Fishery Commission—to address stock identification of Lake Michigan's lake whitefish and proportional harvest of these stocks in the commercial fishery. A fish stock is composed of one or more fish populations that spawn in the same place at the same time and that have specific population dynamic parameters. Because stocks represent the basic fisheries management unit, stock discrimination is an integral part of science-based fisheries management programs. Initially focusing on spawning aggregates of fish, the research team genetically discriminated six stocks of lake whitefish and showed the genetic data capable of mixed stock analysis in the commercial fishery. A follow-up study showed significant mixed stock fisheries throughout the commercial harvest with some locations showing four or more stocks simultaneously contributing to at least ten percent of the total catch. These findings suggested that geographical harvest location was an insufficient surrogate for stock allocation purposes.

The research conducted through this collaborative venture has provided important answers and facilitated development of science-based strategies which are being used by the management agencies to steward this important resource.

Metapopulation Dynamics of the Adélie Penguin

Katie Dugger, Oregon Unit

KATIE DUGGER/OREGON-WILDLIFE UNIT

Oregon Unit Assistant Leader Katie Dugger, graduate students, and a group of U.S. and international collaborators are conducting long-term research on the metapopulation demographics of the Adélie penguin on Ross Island, Antarctica. This species is a sea ice obligate and changes in population size and distribution are occurring in some regions of Antarctica as sea ice patterns change in response to climate change. The core of this project is a long-term data set, with the seventeenth season of data collection in 2012, on individually marked, known-age individuals in a three-colony metapopulation.

The objectives for the current five-year effort are to: (1) determine how age, experience and physiology influence individual foraging efficiency; (2) determine how age, experience, and individual quality influence breeding success and survival in varying environmental conditions; and (3) develop a comprehensive model for the Ross Island metapopulation incorporating all the factors identified as important drivers of penguin vital rates. The data set and the longitudinal, metapopulation analytical framework being used allows for modeling current relationships between vital rates and environmental variation, and will also facilitate predictions in relation to climate change scenarios for the southern ocean. This is a system that has experienced a much smaller human footprint than other regions on the planet. Thus, this project provides a unique and invaluable opportunity to disentangle climate change effects from anthropogenic influences, and will aid in the conservation and management of the Adélie penguin, an important mesopredator in the Antarctic ecosystem.

More information on this project, the collaborators and published research findings can be found at www.penguinscience.com.

Playa Wetlands Investigations

Dave Haukos, Kansas Unit

DAVE HAUKOS/KANSAS UNIT

Playa wetlands are the primary surface hydrological feature of the High Plains region of the western Great Plains. These small dynamic wetlands provided a number of ecological functions and services critical for the High Plains ecosystem including biodiversity, floodwater collection and storage, aquifer recharge, plant refugia, and wildlife habitat. Without playas, relatively few plants, wildlife, and other organisms could persist in the region.

Dave Haukos, leader of the Kansas Unit, has extensively researched playa ecology, conservation, and management. Although the number of playas is typically reported between 50,000 and 80,000 for the High Plains, such reporting provides a misconception that there are sufficient playas to provide ecological services at desired levels. We have recently discovered that for the Southern Great Plains, 17 percent of the historical approximately 30,000 playas no longer exist, 38 percent either have been removed or cultivated, and 60 percent have been lost, cultivated, or filled with sediment. Of the remaining playas, none are fully functional, 47 percent are partially functional, but restorable, 13 percent are partially functional but not restorable due to cost, and 35 percent are partially functional but not restorable due to lack of reliable restoration techniques.

The value of playas is not the individual wetland, but rather all playas in the aggregate that form a complex ecological system. Despite the seven massive landscape changes on the High Plains over the past 150 years, playas have persisted and provide some level of ecological services. This is due to high density of playas that form a redundant, yet resilient system in the face of an unpredictable, dynamic, and extreme environment; anthropogenic landscape changes; and impending climate change. However, within the past two decades as the rate of loss and degradation of playas increases, evidence is accumulating that indicates a threshold level is being approached for the number of playas necessary to provide essential levels of ecosystem services for organism persistence in the High Plains ecosystem.

Mexican Wolves

James Cain, New Mexico Unit

U.S. FISH AND WILDLIFE SERVICE

Mexican wolves were listed as endangered under the Endangered Species Act (ESA) in 1976 and a recovery plan was approved in 1982. In 1997, the Secretary of the Interior approved the reintroduction of Mexican wolves to establish a nonessential experimental population of at least 100 wolves in the Blue Range Wolf Recovery Area of Arizona and New Mexico. Following reintroduction, the population initially increased, however for the past eight years, the population has fluctuated around 50 wolves or half of the reintroduction goal.

Scientists at the New Mexico Unit are assisting the U.S. Fish and Wildlife Service with analyzing a variety of data acquired over the past decade to help elucidate conditions associated with successful introductions and to identify key drivers of wolf population dynamics. Specific objectives are to investigate: (1) habitat colonization preferences and the distribution of preferred wolf habitat across the southwestern U.S.; (2) factors that promote successful releases and translocations; (3) factors that contribute to increased reproductive rates and survival; and 4) dispersal patterns of Mexican wolves. Factors that are demonstrated to be important drivers of vital population rates will be incorporated into a population model that will allow managers to run "what if" scenarios to illustrate the predicted effect of management decisions on wolf population dynamics.

The analyses will also identify areas of preferred wolf habitat and provide a general understanding of the management methods being used, wolf pack structure, and life history of individual wolves to improve success of reintroduction efforts.

The results will help guide future reintroduction efforts, contribute to the development of a new recovery plan, and allow for comparisons between disparate populations to further our understanding of Mexican wolf biology across the established range. The framework and approach developed for Mexican wolves should assist managers tasked with establishing and evaluating reintroduction programs for other carnivores.

Puget Sound Chinook Salmon

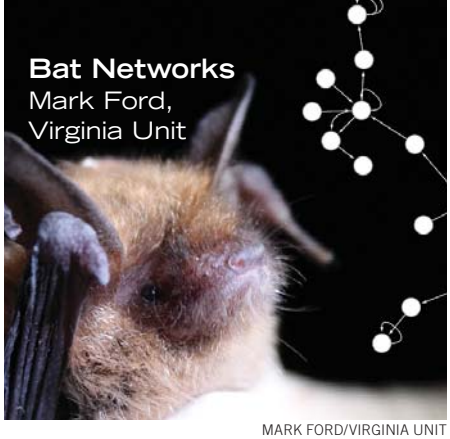
David Beauchamp, Washington Unit

U.S. GEOLOGICAL SURVEY

Salmon spend the majority of their life at sea where they generally achieve 90 percent or more of their growth, but also experience very high mortality. Unfortunately, for many salmon stocks we have a very poor understanding of the dynamics and processes that lead to such high marine mortality even though we can estimate a final mortality rate. Low survival is especially evident in the ESA-listed Puget Sound Chinook salmon where marine survival is typically less than one percent. Consequently, future management of this important resource requires a mechanistic understanding of the processes influencing growth and survival in order to improve results of restoration efforts.

Researchers at the Washington Unit, led by Assistant Unit Leader Dave Beauchamp, have focused on identifying critical periods of growth and key factors affecting growth and survival of Puget Sound Chinook salmon. Using marked hatchery fish, researchers discovered that size at hatchery release was a poor predictor of survival, but that body size of juveniles sampled offshore in July was strongly correlated with survival. Consequently, scientists used bioenergetics modeling to understand the relative importance of diet, temperature, and other factors on growth during this critical period. Bioenergetic models indicated that the availability of crab larvae was a primary determinant of early summer growth and that thermal regime and other factors were much less important. The models developed also suggested that competition for crab larvae could be extremely high given similarities in diet and high spatial-temporal overlap among herring, Chinook, coho, and pink salmon during this critical offshore growth period.

The research is part of an intensive collaborative program being developed to investigate marine survival of salmon and steelhead in the Salish Sea and includes the University of Washington, state, federal, and tribal agencies, the Canada Department of Fisheries and Oceans, and non-governmental agencies from Washington (Long Live the Kings) and British Columbia (Pacific Salmon Foundation).



Bat Networks

Mark Ford, Virginia Unit

MARK FORD/VIRGINIA UNIT

Conservation of summer maternity habitat is considered critical for forest roosting bats in North America, yet how bats are affected by forest structure, composition and change is poorly understood.

Scientists and graduate students at the Virginia Unit are studying factors on northern long-eared bats at the Fort Knox Military Reservation, Kentucky, by radio-tracking female bats to the "day-roost" trees where maternity colonies occur. Northern long-eared bats show a strong preference for roosting in the cavities of particular species of trees, notably small, suppressed live sassafras or sassafras snags underneath the canopy of the installation's hardwood forest. By examining forest composition and tree-ring analyses to understand how these forests originated, the Virginia Unit has determined that these day-roosts are the results of past forest harvesting and land abandonment not mimicked by natural disturbance or current stewardship practices. Resources such as sassafras snags used by northern long-eared bats are ephemeral in nature, perhaps only available for a few years in a condition usable for day-roosting. However, the successional trajectories and forest stand dynamics and processes that established these conditions occurred over many decades. More interestingly, over the entire summer, these maternity colonies form aggregated networks of multiple trees and snags in definable roost areas or patches within the forest. Networks typically have "core" roosts used more by colony members than other trees or snags over the summer.

In addition to documenting network areas, the Virginia Unit and the U.S. Army Engineer Research and Development Center have been experimentally removing roosts as well as creating new roosts to determine if networks can be moved from year-to-year or if such change disrupts the cohesiveness of the maternity colony. Findings from this research are being used to create forest management guidelines to help the Army and other landowners create forest conditions suitable for bats in areas where their presence is compatible with military training needs and other natural resource stewardship activities.

Cerulean Warbler Habitat Management

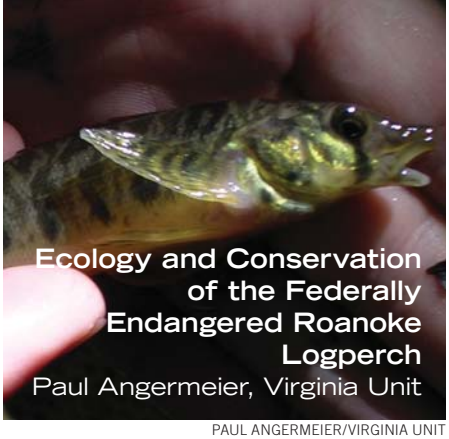
Petra Wood, West Virginia Unit

GREG GEORGE/WEST VIRGINIA UNIT

The Appalachian Region is known for its extensive tracts of mature hardwood forest and high biodiversity. The region is a stronghold for the Cerulean Warbler, a species of high conservation concern due in part to an estimated 70 percent population decline over the last 40 years. Several factors contribute to the decline, including loss and degradation of forested habitat; the amount of forest in the landscape is important as is the quality of the forest.

Cerulean Warblers breed in mature deciduous forests throughout the eastern U.S., but are particularly abundant in oak-dominated forests that contain canopy gaps and a complex canopy structure. Anecdotal evidence suggests that creating canopy breaks in a closed canopy forest improves habitat quality and that timber harvest might be useful for managing forests to benefit this species. The West Virginia Unit, in collaboration with non-governmental organizations, universities, state and federal agencies, and private landowners, recently completed a six-year study designed to identify management practices compatible with Cerulean Warbler conservation. The study quantified abundance, density, nesting success, return rates, and habitat characteristics for this species as well as the response of the overall bird community to forest management. The results provided wildlife managers with a tool for making management decisions to improve breeding habitat for the Cerulean Warbler and other avian species. Habitat management guidelines were also developed and are now being implemented by several states in the Appalachian Region.

The West Virginia and Virginia Units have initiated a follow-up study to evaluate the implementation phase of forest habitat management for the Cerulean Warbler. The focus of this research will be to document population level responses of this and associated species to applied management actions. Results will be used to refine Cerulean Warbler habitat management guidelines.



Ecology and Conservation of the Federally Endangered Roanoke Logperch

Paul Angermeier, Virginia Unit

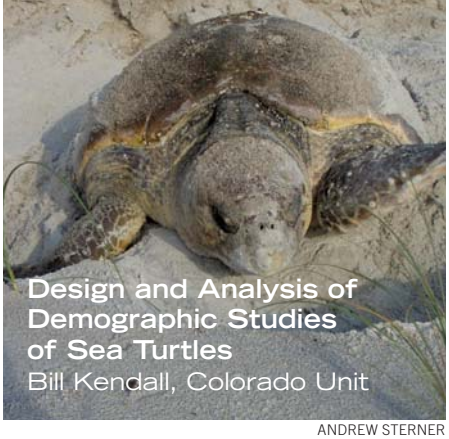
PAUL ANGERMEIER/VIRGINIA UNIT

The Roanoke logperch is an insectivorous fish, less than six inches long, that was listed as Endangered under the U.S. Endangered Species Act in 1989. It is restricted to relatively few piedmont rivers in Virginia and North Carolina and the limited geographic range predisposes logperch to imperilment.

Scientists at the Virginia Unit have been studying the life history and ecology of Roanoke logperch for over 25 years. Initial efforts centered on collecting data on logperch distribution, population size, and movement patterns, and understanding how these varied temporally. The basic information obtained was critically needed by agencies such as the U.S. Fish and Wildlife Service and Virginia Department of Game and Inland Fisheries for determining how to facilitate logperch recovery efforts and to develop the Roanoke Logperch Recovery Plan in 1992.

More recently, we have learned a great deal about logperch ecology in the Roanoke River, our primary study area. Within the Roanoke, we discovered that logperch are more widespread and abundant than initially believed, are highly mobile and vary considerably in abundance across years. To address the broader, range-wide recovery efforts, we've conducted research that determined the spatial structure of populations across the range, population genetics, dispersal among populations, factors affecting annual recruitment, and how to assess sites for potential reintroduction. Through these efforts we identified seven distinctive populations globally that had little opportunity for dispersal among populations; that the population in the upper Roanoke River is the most viable; and that large spring floods limit young-of-year recruitment.

Virginia Unit scientists look forward to continued efforts with our state and federal partners to better understand the ecology of the Roanoke logperch across its range in order to make science-based decisions that balance the ecological and societal needs to ensure their recovery and conservation.



Design and Analysis of Demographic Studies of Sea Turtles

Bill Kendall, Colorado Unit

ANDREW STERNER

Most species of sea turtle are endangered. Conservation of these species is complicated by their complex life history, the broad spatial distribution of various life stages, and their migratory nature. Informed conservation requires monitoring, not only to track general status but to evaluate the effect of management actions that might be taken to conserve these species. Although most sea turtle monitoring consists of population indices based on metrics such as crawl counts, demographic studies based on tagging are important to understanding anthropogenic and other impacts on sea turtle populations. This need was confirmed by a recent National Research Council report on sea turtle status.

The Colorado Unit is working with the U.S. Fish and Wildlife Service, National Park Service, the University of Central Florida, and others to (1) adapt study design and analytical methods to model demographic parameters of sea turtle populations from tagging data; (2) test hypotheses about dynamics of populations nesting at national wildlife refuges, national parks, and elsewhere; (3) evaluate the minimum sampling effort needed to make tagging worthwhile with respect to achieving monitoring goals, for a variety of species and population sizes; (4) develop a guidelines document for conducting sea turtle tagging studies; and (5) train sea turtle biologists in the use of these methods.

Results to date show promise for extracting meaningful inference from a range of tagging studies, from saturation tagging projects of small populations such as hawksbills at Buck Island Reef National Monument, U.S. Virgin Islands, to more diffuse monitoring of the largest population of loggerheads on the Atlantic Coast, at Archie Carr National Wildlife Refuge, Florida.

Restoring Whooping Cranes to Southwest Louisiana: A Cooperative Venture

Sammy King, Louisiana Unit

VLADIMIR DINETS

The prairies and marshes of southwestern Louisiana once supported more Whooping Cranes than any region in North America and included both migrant and resident populations. Shooting and draining of wetlands on the breeding grounds eliminated the migrant population by the early 1900s and the last bird from the resident flock was captured in 1950 at what is now the White Lake Wetlands Conservation Area (WLWCA) near Gueydan, Louisiana. Since that time, the wild flock of Whooping Cranes has been placed on the Endangered Species list and reintroduction programs have been ongoing for the last few decades to facilitate recovery of the population.

Sammy King, leader of the Louisiana Unit, has been intensively involved in recent recovery efforts, including a study to evaluate pre- and post-release of captive-raised birds. During the pre-release evaluation, researchers from the Louisiana Unit addressed Recovery Team questions by evaluating migration routes of wintering sandhill cranes and assessing food availability at White Lake throughout the annual cycle. This knowledge was used in the decision to release 40 cranes at WLWCA between February 2011 and November 2012; additional reintroductions are planned. During the post-release period, Unit scientists have had the lead responsibility for monitoring and research activities. Each Whooping Crane is fitted with a GPS satellite transmitter and about half are also fitted with VHF transmitters. Researchers are documenting habitat use, time-activity budgets, and food availability within rice fields and crawfish ponds. In addition to research and monitoring activities, the scientists assist Louisiana Department of Wildlife and Fisheries (LDWF) with landowner contact and education, educational seminars, grant writing, project planning, and report development. This is a large, multi-agency effort and Sammy is working closely with LDWF, the lead agency, the U.S. Fish and Wildlife Service, International Crane Foundation, Patuxent Wildlife Research Center, and the Agricultural Center at Louisiana State University.

The Cooperative Research Units Program would like to thank each of our cooperators for their continued support.

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Cover photo: A satellite-tagged mountain lion photographed during ongoing study on the effects of landscape connectivity and corridors on the reintroduction of large carnivores in Colorado. Photo courtesy of Colorado Parks and Wildlife.