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Endangered Species Bulletin, March/April 2003 - Vol. XXVIII No. 2

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"Endangered Species Bulletin, March/April 2003 - Vol. XXVIII No. 2" (2003). *Endangered Species Bulletins and Technical Reports (USFWS)*. 9.

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ENDANGERED *Species* BULLETIN

March/April 2003

Vol. XXVIII No. 2



When we think about biological diversity, the plant and animal treasures hidden away in tropical rainforests or the unusual species that evolve on isolated islands readily come to mind. It may surprise many people that the freshwater systems of the southeastern United States contain an extraordinary diversity of aquatic animals. The richest temperate freshwater fish fauna in the world, for example, can be found in the Southeast. Even so, “new” species are still being described as scientists learn more about the complexity of the regions’ biological resources. At the same time, however, habitat alterations, water pollution, invasive nonnative species, and other problems threaten to turn this center of diversity into a center of extinction. Read inside about efforts to save “the jewels in our waters.”



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U.S. Fish & Wildlife Service

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On the Cover

Cambarus dubius, a brilliantly colored species of crayfish, is part of the rich diversity of aquatic wildlife native to the Southeastern United States.

Photo by Guenter Schuster

Opposite page

The aquatic wildlife of the Southeast supports a variety of other animals, such as the raccoon.

Corel Corp. photo



The Endangered Species Bulletin welcomes manuscripts on a wide range of topics related to endangered species. We are particularly interested in news about recovery, habitat conservation plans, and cooperative ventures. Please contact the Editor before preparing a manuscript. We cannot guarantee publication.

We also welcome your comments and ideas. Please e-mail them to us at esb@fws.gov.

The Fish and Wildlife Service distributes the Bulletin primarily to Federal and State agencies, and official contacts of the Endangered Species Program. It also is reprinted by the University of Michigan as part of its own publication, the Endangered Species UPDATE. To subscribe, write the Endangered Species UPDATE, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115; or call (734) 763-3243.



Printed with vegetable-based ink on recycled and recyclable paper. If you do not keep back issues, please recycle the paper, pass them along to an interested person, or donate them to a local school or library.

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Jewels in our Waters

by Sam D. Hamilton

At the crack of dawn, as you slice through the calm river with quiet paddle strokes, your canoe glides upstream through a bank of fog that will slowly burn off with each cast of your fishing rod.

Why does everyone love our beautiful southern rivers, creeks, and lakes? I believe the answer is a personal one. For some, it is relaxing. For others, it is enjoying a day of fishing with your dad,

exploring a new area, or just having fun on a hot summer day. Everyone may not know, however, about the wealth of aquatic life hidden in our waters.

Therefore, it is my pleasure to introduce an edition of the *Endangered Species Bulletin* devoted to the conservation of southeastern aquatic species and the ecosystems upon which they depend.

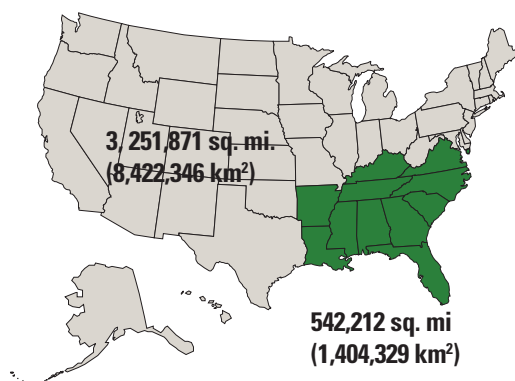
The rivers that run through the Southeast support a variety of life. Would you be surprised to discover that hiding in some of our southeastern rivers are fish that rival in beauty those found on coastal coral reefs? People generally are unaware of the vast biological diversity contained within the rivers and streams of the southeastern United States. Many scientists, however, are well aware of the treasures we have and are concerned about their future.

This cypress swamp, below, part of Bond Swamp National Wildlife Refuge in Georgia, is home to a variety of freshwater and anadromous fishes, including the endangered shortnose sturgeon.

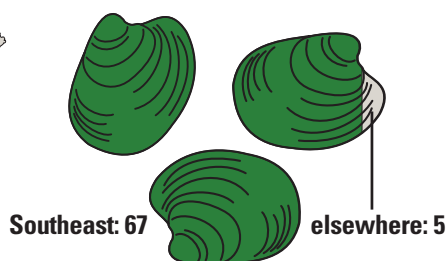
USFWS photo by John and Karen Hollingsworth



Total Area



Listed Mussels



Listed Fishes



Constituting just 14.3% of the area of the United States, the southeastern states are home to 30.9% of its listed fishes, and 93% of its listed mussels.

The richest temperate freshwater fish fauna in the world (approximately 530 taxa, or 66 percent of the freshwater species of North America) occurs in the southeastern states of Arkansas, Louisiana, Mississippi, Alabama, Florida, Georgia, North and South Carolina, Virginia, and Kentucky¹. Of the more than 110 federally listed fishes, 34 taxa (18 endangered, 16 threatened) are found in the Southeast. The situation is even worse for mussels: 72 species of mussels are federally listed nationwide, and 67 of these (59 endangered, 8 threatened) are in the Southeast. Overall, the largest concentration of freshwater biodiversity in North America is found in just four southeastern states: Alabama, Georgia, Tennessee, and Kentucky².

Although the Southeast is an epicenter of aquatic biodiversity, it is also an epicenter of imperilment and extinction. Historically, the causes for the decline of southeastern aquatic species included dam construction, dredging, channelization, mining, deforestation, and pollution. Today, actions by our partners, such as the Tennessee Valley Authority, are beginning to lessen the

impact of some of these threats. However, our aquatic species still face increasing threats. As our nation's cities continue to grow, water demands continue to skyrocket, destruction of habitat continues, nonpoint source pollution (such as sedimentation) increases, and impacts resulting from the introduction of nonnative (or invasive) species continue to devastate native aquatic species.

How can we conserve southeastern aquatic species and their habitats?

1) First, we must answer this question: how many aquatic species are hidden in our southeastern waters? Through advances in both technology and theory in systematic and evolutionary biology, scientists are beginning to discover the true extent of biodiversity in southeastern waters. (See "Cryptic Biodiversity" in this edition of the *Bulletin*, page 24.)

(2) We must continue to work with our partners. With broad-based land-owner support, many hours of work from groups like The Nature Conservancy and The World Wildlife Fund, cooperation from local governments, and the technical expertise and assistance from state agencies like The Tennessee Wildlife Resources Agency and groups like Conservation Fisheries, Inc., we have been able to restore some essential habitat for aquatic species and, in certain cases, reintroduce or augment wild populations.

(3) We must make greater efforts to conserve species before they require federal protection.

(4) We must continue our efforts to support research and learn more about aquatic faunal groups, like crayfish, that are not very well known.

(5) We must work more effectively to create consensus-based regional conservation and recovery strategies for aquatic species across the Southeast.

(6) We must continue to secure funding and devote staff time to conserving and recovering the jewels of our southeastern waters.

I am very pleased that efforts we have participated in, initiated, or helped fund, with the strong support of so many of our partners, reach practically every major river system in the Southeast. In that spirit, I hope you'll enjoy this issue of the *Endangered Species Bulletin* devoted to the conservation of southeastern aquatic species and their ecosystems.

Sam D. Hamilton is the Southeast Regional Director for the U.S. Fish and Wildlife Service.

1. Biggins, R., N. Burkhead, S. Walsh, V. Mudrak, and K. Bibb. 2000. Strategy for the Conservation and Recovery of Southeastern Imperiled Fishes. 35 pp.

2. Johnson, P. D. 2001. Musseling in on Biodiversity. National Wetlands Newsletter.

by Kelly Ann Bibb

Conservation and Recovery of Southeastern Imperiled Fishes



Pygmy madtom

Photo © Conservation Fisheries, Inc.

Prompted by concern over the plight of southeastern fishes and a desire to address their conservation, the Fish and Wildlife Service organized a meeting of more than 60 aquatic natural resources experts in October 1999. Professionals representing state and federal natural resource management agencies, academic institutions, conservation organizations, and industries agreed to create a consensus-based action plan: the “Strategy for the Conservation and Recovery of Southeastern Imperiled Fishes.”¹ The purpose of the strategy is to provide direction and guidance for the conservation and recovery of these fishes and it’s the first of its kind nationwide. It is a collective road map built by a group of partners united around a common cause: the desire to shepherd into the next century a healthy and productive network of southeastern rivers and streams supporting a full diversity of aquatic life while providing resources to people.

This unique strategy assisted in starting a watershed community-level conservation effort, the Upper Coosa River Summit. The approach helped partners outline and prioritize conservation actions desperately needed in the Upper Coosa River, located in north Georgia at the top of the Mobile River

Basin. This river is a hotspot for imperiled species, but there is a high potential for improvement to the watershed, especially with help from partners like those in attendance at the summit (such as Georgia Department of Natural Resources, The Nature Conservancy, the local river alliances, and Conservation Fisheries, Inc.).

The group that developed the strategy (The Southeastern Imperiled Fishes Team or SIFT) reconvened in January 2001 with several new partners to reaffirm the goals, get commitments from new members, and form the body that will advance the strategy. The World Wildlife Fund, Tennessee Aquarium, the Service, other federal and state agencies, conservation organizations, industry, and academic institutions were elected or volunteered as lead chairs or part of the SIFT steering committee. SIFT completed the meeting by initiating a framework of how goals will be achieved within the next year. A mission statement from SIFT highlights its approach:

“... advance conservation and recovery of southeastern imperiled fishes and their aquatic ecosystems for the benefit of current and future generations through scientific based research, management, communication, education and cooperation.”

An example of how SIFT participants are working together under the strategy involved the pygmy madtom (*Noturus stanauli*) release in May 2001. The pygmy madtom is one of the rarest fishes in North America; only about 50 specimens have ever been collected.

¹Biggins, R.G., N.M. Burkhead, S.J. Walsh, V.A. Mudrak, and K.A. Bibb. 2000. Strategy for the Conservation and Recovery of Southeastern Imperiled Fishes. 35 pp.

Professor Rick Mayden and his students from the University of Alabama initially found two pygmy madtoms during sampling for other fish (luckily, one male and one female). J.R. Shute and Pat Rakes at Conservation Fisheries, Inc., took these fish into captivity and were able to propagate and raise 13 new pygmy madtoms—a first and a truly extraordinary achievement. With the support of Richard Kirk and the Tennessee Wildlife Resources Agency, the World Wildlife Fund, and The Nature Conservancy, a reintroduction of these madtoms was planned into the Clinch River in Tennessee. With the generosity of two local landowners who support aquatic conservation, access was allowed to a site on the Clinch River, and 6 of the 13 pygmy madtoms were released back into their natural habitat.

In June 2001, the Service entered into and provided funding for a cooperative agreement with the National Fish and Wildlife Foundation. This agreement allows federal funds to be leveraged with funds from other sources to support on-the-ground projects that benefit our imperiled aquatic resources. Projects supported by the Foundation under this agreement will focus on enhancing and protecting freshwater and estuarine fish resources, and could include conservation education, habitat protection and restoration, and other resource management projects that support the goals and objectives outlined in the strategy.

A request for proposals related to this cooperative agreement was broadcast in October 2001. The first four projects to be funded under this agreement and the first of many to support the Strategy include working to:

(1) incorporate southeastern imperiled fish photos into NatureServe (a former branch of The Nature Conservancy), one of the leading biological information databases on the web and a major educational tool that has a global reach;

(2) develop propagation techniques for the vermilion darter (*Etheostoma chermocki*), ultimately leading to captive propagation of this fish, which occurs

At right, top to bottom: A crowd gathers to watch the release of pygmy madtoms into the Clinch River; Pat Rakes of Conservation Fisheries, Inc., releases the captive-bred fish, as David Sims of the Tennessee Wildlife Resources Agency films the event; the Clinch River is a medium-sized river of eastern Tennessee.

Photos by Kelly Ann Bibb/USFWS

only in a small reach of one tributary in the Black Warrior River drainage in Alabama (protecting this fish through captive propagation and simultaneously working to restore its habitat will facilitate its survival);

(3) begin a video library of native fish footage of many of our southeastern imperiled fishes in their natural habitat or up close in aquarium settings (will be an effective education tool for the general public and natural resource managers; still photographs can never capture what live action film can); and

(4) enhance the ongoing lake sturgeon reintroduction efforts in the Tennessee River System under the leadership of the Tennessee Aquarium and Southeast Aquatic Research Institute (a long-term multi-partner effort, with agencies like the Tennessee Valley Authority, Tennessee Wildlife Resources Agency, World Wildlife Fund, and the Service, to benefit and restore an important fish back to an area where it historically occurred).

A second request for proposals was broadcast in summer 2002, and the Service has received additional proposals for work to support the Strategy. Working with partners is a key to the Service's mission and will be a key to the success-



ful implementation of this Strategy. The Service is confident that this Strategy is the beginning of an effective model for aquatic conservation.

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by Shane D. Hanlon

Releasing Mussels to Recovering Waters



A handful of 3-month-old juveniles of the wavyrayed lampmussel (*Lampsilis fasciola*) propagated at Virginia Polytechnic Institute and State University and reared at the Virginia Department of Game and Inland Fisheries' Aquatic Wildlife Research Center.

Photo by Shane D. Hanlon

One of our nation's biological hot spots, the 21,390 square miles (55,379 sq. kilometers) of the Upper Tennessee River Basin (UTRB) provides habitat for a remarkable diversity of aquatic life. More than 85 of the approximately 300 described North American freshwater mussel species have been recorded here, representing one of the most diverse mussel assemblages in the world, with many occurring nowhere else. Five major Tennessee River subbasins (the Clinch/Powell, Holston, French Broad, Hiwassee, and Little Tennessee) contribute to the UTRB, which stretches its extensive network of tributaries through parts of Tennessee, Virginia, North Carolina, and Georgia.

Prior to the industrial revolution, freshwater mussels thrived in these waters. Over the past century, however,

mussels have been plagued by numerous human activities and are now considered the most endangered faunal group in North America. Mussel populations have been decimated by impoundments; poorly managed mining operations; toxic spills; industrial, domestic, and agricultural pollution; and silt-laden waters from eroding landscapes. The Fish and Wildlife Service currently lists 30 mussel species of the UTRB under the Endangered Species Act (ESA) as endangered. Eleven species native to the basin in historical times are believed to be extinct. Only 26 of the nonlisted species are considered stable.

Freshwater mussels provide us with important ecological benefits. They are a significant food source for many aquatic and terrestrial animals. They filter particulates and excess nutrients from our rivers, thus improving water quality. Declining mussel populations signal potentially serious environmental and

Site along the lower French Broad River, Tennessee, where common mussels are being released to test the suitability for the reintroduction of endangered mussels.

Photo by Richard Biggins/USFWS



public health problems. Because mussels are long-lived and virtually immobile, they cannot escape pollutants. Therefore, mussels have been referred to as “silent sentinels” that indicate chronic impacts to water quality. In addition, mussels’ lack of mobility renders them susceptible to massive die-offs from acute stresses, such as chemical spills. Without mussels, these spills might go unnoticed, because more mobile aquatic fauna can exit or drift downstream of an impacted area before perishing, leaving no visible trace of the harm that can be done to the aquatic ecosystem.

Prior to the first ESA listings of freshwater mussels in 1976, declining freshwater mussel populations were largely ignored. Today, numerous federal, state, tribal, and local agencies; conservation groups; and local communities are recognizing the value of these animals and are advocating mussel conservation. In the UTRB, local watershed groups are growing in number. In the Virginia portion alone, more than 20 nongovernmental organizations and coalitions have spearheaded the demand for improved water quality for biological diversity, as well as for human use.

Given the large scale at which the UTRB watershed has been altered, it is a daunting task to protect and restore it. Nevertheless, agencies and conservation groups are making significant accomplishments. Since the early 1980s, under the leadership of the Service and with the commitment of many partners, a major mussel recovery program is underway. These partners include the Virginia Department of Game and Inland Fisheries (VDGIF), U.S. Forest Service, U.S. Geological Survey (USGS), Tennessee Wildlife Resources Agency (TWRA), Tennessee Valley Authority, Soil and Water Districts, Upper Tennessee River Round Table, Nature Conservancy, and Black Diamond Resource Conservation and Development, Inc.

Many streams throughout the UTRB have been degraded by poor land management practices. Since 1991, the Service’s Partners for Fish and Wildlife

program has collaborated with private landowners and other community partners to conduct hundreds of stream restoration projects on private lands in the UTRB. More than 50 miles (80 km) of riparian corridor have been restored to benefit endangered mussels and a rich diversity of native fishes, snails, crayfish, amphibians, and other aquatic organisms. Improving habitat for mussels also benefits sport fisheries, improves water quality for people, and increases aesthetic value.

For many endangered mussel species, habitat improvement alone may not be enough to prevent extinction. Densities have become so low that natural reproduction can no longer sustain the population. With support from the Service, TWRA, and VDGIF, researchers from the USGS/Biological Resources Division at Virginia Polytechnic Institute and State University have worked diligently to develop captive propagation techniques for endangered and threatened mussels. From 1998 through 2001, nearly 260,000 juvenile mussels of eight endangered species and one of special concern were propagated and released to two major river systems (Clinch/Powell and Hiwassee River systems) to augment declining mussel populations. These species include the fanshell (*Cyprogenia stegaria*), dromedary pearlymussel (*Dromus dromas*), Cumberlandian combshell (*Epioblasma brevidens*), oyster mussel (*Epioblasma capsaeformis*), tan riffleshell (*Epioblasma florentina walkeri*), snuffbox (*Epioblasma triquetra*), purple bean (*Villosa perpurpurea*), birdwing pearlymussel (*Lemiox rimosus=Conradilla caelata*), and cracking pearlymussel (*Hemistena lata*).

In 1998, the VDGIF established the Aquatic Wildlife Conservation Research Center to expand propagation activities. The facility, located at their Buller Fish Culture Station near Marion, Virginia, has shown promising results in rearing juvenile mussels using water from the nearby Holston River to simulate natural river conditions. The VDGIF conducted its first release of hatchery-reared

mussels in 2001. More than 2,300 juvenile mussels were released to the Clinch River in Clinchport, including juveniles of the wavyrayed lampmussel (*Lampsilis fasciola*) and two endangered species, the Cumberlandian combshell and oyster mussel. Researchers at the Virginia Cooperative Fish and Wildlife Research Unit developed the propagation techniques and assisted in the release. Research is underway to develop propagation technologies for other endangered mussels and to identify additional stream reaches suitable for augmentation. The Service and its partners plan to produce and release juvenile mussels of several imperiled species to augment additional populations within the Clinch/Powell and North Fork Holston in Virginia.

Using an ecosystem approach, the Service’s conservation initiatives and partnerships are fundamental to prevent the extinction of many freshwater mussel species. Through these efforts, populations of imperiled species may once again be able to sustain themselves and thrive in restored habitats, benefitting not only one of the richest aquatic communities in the nation, but ultimately the human communities that depend on good water quality and the conservation of aquatic biodiversity.

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by Robert S. Butler,
Robert J. DiStefano, and
Guenter A. Schuster

Crayfish: An Overlooked Fauna



Many crayfish display surprisingly brilliant hues of blue, green, orange, red, and yellow, sometimes in dazzling combinations. Others have spots or mottled patterns, bold stripes or bands, or are albino. Above is *Cambarus dubius*, one of many species with no common name.

All photos by Guenter Schuster

Whether you know them as mudbugs, ditch bugs, river lobsters, crawlybottoms, crawdads, or crawfish, anyone who has spent time in streams is familiar with crayfish. Chances are you've eaten them in southern restaurants or social gatherings, used them for fish bait, or played with them in streams. The probability is also high—even among aquatic biologists—that you know little about them, including the possibility that they may represent one of the continent's most imperiled aquatic groups. But you are not alone.

Crayfish are so poorly known that over half of them don't have common names. The ones that do include fanciful names such as Cajun dwarf crayfish (*Cambarellus shufeldtii*), phantom cave crayfish (*Procambarus pecki*), bottlebrush crayfish (*Barbicambarus cornutus*), devil crawfish (*Cambarus diogenes*), ditch fencing crayfish (*Faxonella chypeata*), Piedmont blue burrower (*Cambarus harti*), and even the rusty grave digger (*Cambarus millus*).

Crayfish represent one of the largest aquatic faunal groups in North America north of Mexico, with approximately 353 known species, or nearly two-thirds of the world's crayfish fauna. Almost all crayfish in the United States occur east of the Continental Divide and comprise the family Cambaridae (335 taxa), primarily in the genera *Cambarus*, *Procambarus*, and *Orconectes*. Astonishingly, about 95 percent of the U.S. species occur in the Southeast, making this region the global center of crayfish diversity. Recognized biodiversity is rapidly expanding; 45 species were formally described between 1988 and 1996 alone (Taylor et al. 1996). Ultimate crayfish diversity may exceed 400 species.

Crayfish thrive in creeks and rivers, lakes and ponds, swamps and ditches, even pine flatwoods and wet meadows. Stream forms are most diverse. Physiographic integrity—restriction to a particular province or subsection—is displayed by many crayfish. *Cambarus* species primarily occur in the Appalachian Highlands, *Orconectes* species are generally found on the Interior Low Plateau, and *Procambarus* species are mostly Coastal Plain endemics. Many, primarily Coastal Plain crayfish, excavate burrows whose entrances are conspicuously marked by mud-ball "chimneys." About 40 troglotic (cave-dwelling) species live in subterranean streams, and have lost their eyes and pigments.

Crayfish mate in fall through winter. A male courts a female by touching her with his antennae and chelae (claws). During copulation, he deposits sperm into her sperm receptacle and places a plug in it, perhaps to retain his sperm or prevent other males from mating with her. After fertilization, she glues the eggs to her swimmerets (swimming legs), then sequesters herself in a safe place while "in berry" (her egg mass resembles berries). Hatching takes place after a few



These three specimens illustrate the morphological diversity of the group. From left to right: bottlebrush crayfish (*Barbicambarus cornutus*), *Orconectes lancifer* (no common name), and “*Cambarus new species*,” an as yet unnamed member of the genus *Cambarus*.

weeks. Juveniles have three stages and stay with mom for weeks before striking out.

Sexually mature males have two annually cycling forms: the reproductively active Form I and sexually inactive Form II. Generally, males are in Form II during the summer months. In late summer or fall males molt into Form I, and actively pursue mating. Molting, or the shedding of the carapace (exoskeleton) to allow for growth, is a critical time for crayfish due to increased vulnerability to predation and pollutants. North American crayfish 5 to 7 inches (12 to 17 centimeters) long are considered large. They live 1.5 to 3.5 years, but troglobitic crayfish species may live several decades.

Crayfish play many important roles in their ecosystems. They are omnivorous, processing organic matter and transforming energy between different levels in the food chain, and are eaten by more than 240 predators.

Long a favorite in Cajun cuisine, a commercial crayfish industry is centered in Louisiana. Having an average annual value of \$91 million, 87 million pounds are annually produced from pond culture and wild harvested stock. Crawfish festivals celebrating this delectable decapod are well known in the Deep South. A Crayfish Derby has been held in Columbia, Missouri, for 15 years.

Crayfish are susceptible to habitat damage caused by impoundments, stream channelization, pollution, and sedimentation. Probably the biggest threat is nonnative crayfish introduced as fishing bait. Introduced crayfish may compete with natives for shelter, hybridize with them, and destroy vegetation beds used by native crayfish and other organisms for foraging, nesting, and shelter. One introduced species in particular, the rusty crayfish (*Orconectes rusticus*), has displaced native species in many areas.

The degree of crayfish imperilment may exceed that of fishes, and is second only to the most imperiled group in North America, freshwater mussels. Conservation biologists estimate that 48 percent of our crayfish fauna deserve conservation status. At present, however, only four are listed under the Endangered Species Act: two cave crayfish (*Cambarus aculabrum* and *C. zophonastes*) in northern Arkansas with no common names, the Nashville crayfish (*Orconectes shoupi*) in central Tennessee, and the Shasta crayfish (*Pacifastacus fortis*) in northern California.

Taylor et al. (1996) played a major role in highlighting the plight of this largely overlooked aquatic group. Conservation biologists are helping by

hosting workshops focused on crayfish identification, distribution, ecology, and status. Some Fish and Wildlife Service ecosystem teams are generating reports and considering management strategies for potentially imperiled crayfish. These efforts are making crayfish more of a consideration in the management, restoration, and conservation of our Nation's aquatic resources.

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Reference

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The Urban Life of Darters

by Daniel J. Drennen



Male (top, showing breeding colors) and female vermilion darters.

Illustrations © Joseph Tomelleri

Most people in the United States now live in urban areas and suburbs, squeezed onto three percent of the nation's land area. In turn, most of the water that enters our southeastern streams and lakes is affected by activities that occur on these developed lands, such as storm water drainage and the construction of buildings, houses, roads, and parking lots. In the Pinson community of Jefferson County, Alabama, just northeast of Birmingham, three fish species are endangered by excessive sedimentation in urban streams.

Too much sedimentation can affect the habitat of darters and associated fish species by making urban streams and lakes unsuitable for feeding and reproduction. Sediment abrades and suffocates organisms that are attached to submerged substrates (such as rocks, sticks, and leaf litter), disrupts aquatic insect natural processes like feeding and reproduction, and depresses fish growth, survival, and reproduction. The species that have evolved over thousands of years in these waters are put at risk.

The freshwater fish species—the watercress darter (*Etheostoma nuchali*), listed as endangered in 1970; the rush darter (*Etheostoma phytophilum*), a listing candidate; and the vermilion darter (*Etheostoma chermocki*), a species listed as endangered in 2001—have the most restricted distributions of any vertebrates in Alabama. The watercress darter was transplanted in the Tapawingo/Penny Springs area of Turkey Creek in 1988 and has endured, even though urbanization and sedimentation threaten its survival. A recent evaluation of the watercress darter's population indicates that it has expanded throughout the Tapawingo/Penny Springs

waterways that have not been degraded by sediments. The rush and vermilion darters, however, have declined significantly throughout the Turkey Creek watershed of the Locust Fork of the Black Warrior River.

The Fish and Wildlife Service is now researching the rush darter to better understand its natural history, locality, and population ecology within the Turkey Creek watershed. Up to now, the rush darter, a species not described until 1999, had received little attention. Populations of rush darters are widely separated from one another. Historically, rush darters were found in three watersheds: the Clear Creek system in Winston County, the Tapawingo/Penny Springs area of the Turkey Creek system in Jefferson County, and the Little Cove Creek system in Etowah County. Currently, however, only two rush darter populations remain in the Clear Creek and Turkey Creek systems. Researchers at Auburn University estimated the species' total population at 500 individuals or fewer throughout its entire range. The rush darter's type locality is in a roadside ditch on a highway through Pinson and the Tapawingo/Penny

Springs area. One catastrophic event could easily destroy this important habitat. The vermilion darter is found only in 7.2 miles (11.5 kilometers) of the main stem of Turkey Creek and the lowermost reaches of two tributaries within the Turkey Creek drainage. Researchers at the University of Alabama estimated the population of vermilion darters as fewer than 3,500 individuals. In 1998, a county jail was proposed for construction on an area adjacent to Turkey Creek, and it would have had direct sedimentation impacts on the vermilion darter and the watershed. This concerned the local community and led it to galvanize support for the protection of Turkey Creek by forming START (Society to Advance the Resources of Turkey Creek). Ultimately, after negotiations between Jefferson County and START, the jail site was changed to a location outside the watershed. Concurrently, Jefferson County proposed the former 600-acre (240-hectare) jail site along Turkey Creek as a nature preserve, and plans have been made for a nature center and management of the acreage.

The Service met with stakeholders of the watershed, including START and Jefferson County, concerning the distribution, threats, and status of the vermilion darter. To lessen threats to the vermilion darter, START participated in several "Partners for Fish and Wildlife Projects" aimed at minimizing nonpoint source pollution within Turkey Creek. Additionally, the Black Warrior and

Cahaba River Land Trust and the Service identified important lands within the watershed for possible acquisition by the Jefferson County Greenways Project. One such site, the Tapawingo/Penny Spring area, a clean water tributary of the creek and a spawning site for the vermilion and possibly rush darters, was purchased by Jefferson County. It also contains a viable population of watercress darters. This area has been restored with assistance from the Service.

In 2001, the Service signed a Memorandum of Understanding with Jefferson County that will alert us to any county projects that may affect the vermilion darter's habitat. In return, we exchange information about vermilion darter range locations and habitat requirements with the county.

Threats to the three darter species are mounting due to increased sedimentation of the Turkey Creek watershed caused by urbanization. However, networking of stakeholders through meetings with the Service has spotlighted the importance of sediment control in the watershed. By working closely with its partners, the Service will not only be able to more effectively reduce sediment loads coming into these darters' streams, but

will also be able to address impacts of storm water runoff, sewage effluent, road maintenance, and construction of homes and businesses on the watershed, with the goal of conserving clean water for fish and people alike.

Daniel J. Drennen is a biologist in the Service's Jackson, Mississippi, Field Office; 601/321-1127; daniel_drennen@fws.gov).

Below: Vermilion darter habitat, Turkey Creek. Bottom left, Tapawingo Springs, home of the rush and watercress darters, surrounded by houses and a trailer park. Bottom right, construction site of a subdivision being developed on Turkey Creek vermilion darter sites.

Photos by Daniel Drennen/USFWS



Forty-One Tons

by Tyler Sykes

The boulder darter, a member of the perch family, reaches a maximum length of about 3 inches (7.5 centimeters).

Photo by Richard Biggins/USFWS

Inset: After this truck dumped boulders at the river's edge, volunteers lugged them into place to enhance habitat for the endangered boulder darter.

Photo by Tyler Sykes/USFWS

Why would 30 people volunteer to move large boulders, by hand, into the Elk River on a hot day in August? “In the hopes of providing new habitat for one of the rarest fishes in the Southeast,” replies Lee Barclay, Supervisor of the Cookeville, Tennessee, Field Office of the U.S. Fish and Wildlife Service. He is talking about the boulder darter (*Etheostoma wapiti*) and the massive undertaking organized by the Lower Tennessee/Cumberland Ecosystem Team in August 2001 for this little fish.



The boulder darter was first seen in the Elk River drainage in 1891 and has never been found in any other river. As a result, it was originally called the Elk River darter, but this changed when it was discovered that the species spends its entire life in close proximity to boulders on the river bottom. This habitat specificity is one of the reasons the fish is now so rare.

"Areas in the Elk River with these boulders are hard to find," notes Pat Rakes, co-director of Conservation Fisheries, Inc. (CFI), a Knoxville-based nonprofit organization working to protect and restore rare fishes to southeastern rivers and streams. For years, this limited habitat has been polluted by cities, industries, and farms along the river. Water temperatures and levels also have changed due to construction of dams on the Elk and Tennessee rivers. As a result, the numbers of boulder darters decreased over the years, leading the Service to list the boulder darter in 1988 as an endangered species.

Rakes and CFI co-director J.R. Shute have spent many hours surveying the Elk River and its tributaries for the boulder darter and suitable habitat. Based on this work, the boulder darter is currently believed to be limited to a 63-mile (101-kilometer) stretch of the Elk River and a few of its larger tributaries in southern Tennessee and northern Alabama. Within this region, the species is found only in areas that have adequate boulder habitat. Boulder darters use these rocks for spawning substrate and cover. Rakes explains that "the female boulder darter attaches her eggs to the bottom of these rocks and the male has the job of fertilizing them and then guarding them until they hatch." Subsequently, lack of this habitat could result in the eventual demise of the species. Members of the Lower Tennessee/Cumberland Ecosystem Team and other partners came up with the idea of augmenting the existing habitat with the limestone slabrocks preferred by the boulder darter.

Volunteers from the Service, Tennessee Wildlife Resources Agency, Tennes-

see Valley Authority, CFI, International Paper, and private citizens placed 41 tons of rock into the Elk River at two locations: one near Fayetteville and the other at an old mill dam near Dellrose. Limestone boulders from a rock quarry in Woodbury, Tennessee, were taken to the two sites by personnel with Noland Stone Company in Nashville.

The two locations selected were chosen because the surveys conducted by Rakes and Shute indicated that boulder darters were known, either historically or currently, from these sites and that the limited habitat could be augmented with additional rock. As a result, approximately 18 of the 41 tons were placed into the river at Fayetteville and the remaining 23 tons went to Hamilton Mill. "This work was not for the faint of heart or back," says Barclay. Moving these boulders took several hours over a two-day period. After the rocks were set in place, captive-reared boulder darters were released at both stream locations.

The fish released were the young of boulder darters collected from the Elk River by CFI during 1997-2000. Rakes and Shute have worked for years learning how to breed rare fish in captivity, and they have had great success doing so with a number of rare fish, including the boulder darter. Their work is aimed at producing fish that can be returned to the wild to help bolster rare species. They produced 500 boulder darters that were released at the sites.

Each fish was marked with a colored tag that allows biologists to determine when and where particular boulder darters were released. "We will be able to tell how far the boulder darters are traveling up and down the river, how long they live in the wild, and whether or not they are using the boulders we put in the river," explains Shute.

Are these efforts effective? Past attempts are encouraging. In the summer of 1999, some of the same volunteers that came together this time were present for the placement of slabrock at the I-65 bridge crossing of the Elk River

near the Town of Pulaski in Giles County, Tennessee. Approximately 3.5 tons of rock were placed at this location in the riffle areas above and below the bridge crossing. Captive-reared boulder darters were released at the site at that time and the following year. Biologists with CFI revisited the site soon after the second release to look for boulder darters in the area of the slabrocks. Within a few hours of snorkeling, they discovered 16 boulder darters, most of them using the rocks that had been placed the year before. This was and still is the largest concentration of boulder darters ever found on the Elk River. The rocks are being used not only by the boulder darters, but also by an assortment of other fish.

Because water quality in the Elk River is improving, and because we have discovered ways to provide additional habitat in the form of natural slabrocks, more areas in the Elk River are ready for boulder darters. To give them a hand, several other people are getting involved in raising boulder darters for release to the wild. The Dale Hollow and Chattahoochee Forest National Fish Hatcheries are helping CFI to raise more boulder darters for future releases. More releases mean more rocks... calling all volunteers!

All of these efforts for a little fish? Why? "Because the boulder darter plays some role in the environment that we may not yet understand, but we certainly don't want to lose," states Richard Kirk, Endangered Species Coordinator with the Tennessee Wildlife Resources Agency. Barclay adds that, "...if efforts like these continue to prove successful, we may one day be able to remove the boulder darter from the endangered species list."

by Tyler Sykes

Landowners are Recognized for Conservation Work



Jewell Murphy accepts a framed print of the Barrens topminnow in appreciation for conserving the fish on her property.

Photo by Tyler Sykes

At a dinner held in April 2002, 20 private landowners from the Morrison-Viola area of middle Tennessee were recognized by the Barrens Topminnow Working Group for their efforts to restore and protect habitat for this extremely rare fish.

The Barrens topminnow (*Fundulus julisia*), a small fish that we believe occurred historically in spring habitats throughout a

portion of south-central Tennessee, was until recently known to survive at only two locations in the wild, both on private land in Coffee County, Tennessee. The decline of this species in the wild may be reversing, however, thanks to the interest and efforts of private landowners in the area.

The Barrens topminnow lives in springs and spring runs that provide cool, clear waters for the fish to feed and reproduce. These areas were once probably widespread, but conversion to farm ponds, overuse by livestock, drought, and other factors have resulted in the loss of this habitat. As a result, numbers of Barrens topminnows have declined drastically.

In an effort to reverse this trend, the U.S. Fish and Wildlife Service, in conjunction with the Tennessee Wildlife Resources Agency; The Nature Conservancy; Tennessee Valley Authority; Tennessee Aquarium; Conservation Fisheries, Inc.; Tennessee Technological University; and Southeast Missouri State

University, formed the Barrens Topminnow Working Group. The group seeks to address the topminnow's decline through the protection of the two remaining wild populations, restoration of spring habitat, captive propagation, and restocking of Barrens topminnows throughout the species' historical range. Both of the current and all known historic locations for this fish are on private property. As a result, the willingness of local landowners to work with the group is the key to the success of this effort.

The group is working with willing private landowners to protect existing springs and restore suitable habitat through the use of improved management practices on their property. These practices have included the installation of livestock-exclusion fencing around the springs and associated spring runs; construction of hardened feeding areas, stream access, and crossings to reduce erosion in these areas; and installation of watering tanks for cattle. These practices not only improve water quality for aquatic species like the topminnow, but also for local citizens.

The dinner last April was organized to recognize those landowners who have allowed for the rehabilitation and/or protection of suitable habitat and who,

in some cases (six to be exact), have allowed the stocking of this rare fish on their property. These landowners were individually recognized by Brad Bingham, the Service's representative on the Barrens Topminnow Working Group. Other members of the group then presented the landowners with various tokens of appreciation, including passes to the Tennessee Aquarium and a framed print of the Barrens topminnow by Joe Tomellari, a renowned fish illustrator.

Gary Moore of the Natural Resources Conservation Service's Conservationist District for Grundy and Coffee counties, was also recognized by the group for his tireless efforts to work with the landowners in these counties to protect and restore habitat for the topminnow. The entire project would not have been as successful without the trust and respect he has garnered from local landowners. In appreciation, the working group presented Mr. Moore a plaque for his continuing efforts.

In addition to the guests of honor and their families, the dinner was well attended by members of the working group, state agency personnel, and representatives from the offices of Congressmen Bart Gordon and Van Hilleary. All enjoyed a meal catered by Prater's Barbeque and musical entertainment provided by the bluegrass and gospel group, the Buck Mountain Boys.

We hope that more events such as this can be held in the future to recognize other landowners who participate in the project as efforts to conserve this rare fish and its habitat continue.



Barrens topminnow illustration © Joseph Tomellari



At left, Barrens topminnow habitat on private land.

Above top left photo by Pat Rakes/
Conservation Fisheries, Inc.
Above and left photos by Brad
Bingham/USFWS



At right, scenes from the landowner appreciation dinner: landowners Tommy Murphy, Jewell Murphy, and Ida Ramsey; Brad Bingham addresses the group; and the Buck Mountain Boys provide musical entertainment.

Photos by Tyler Sykes





In Memoriam: *Tyler Alley Sykes*

Editor's note: The following was provided by the Service's Cookeville, Tennessee, Field Office in tribute to the memory of Tyler Sykes, who tragically passed away due to illness shortly after she wrote the preceding articles.

Tyler Sykes joined the Fish and Wildlife Service in 1998 as the Endangered Species Recovery Coordinator in the Cookeville, Tennessee, Ecological Services Field Office. She brought to her job a tremendous love for natural resources along with the dedication and determination to accomplish the objectives she set. Tyler had boundless energy and the persistence to stick with even the most difficult task, but she was always quick to smile and had a bright personality that lit up the office. Tyler was outgoing and never failed to speak out for the rare species she was entrusted to protect, but her willingness to listen and work cooperatively gained her the respect of even the most adversarial personnel. She was truly a rising star in the Service. Tyler accomplished tremendous things in her short career and left lasting marks in the hearts of her colleagues. Years from now, one will be able to travel throughout Kentucky and Tennessee and see testimonials to Tyler's dedication and hard work in thriving populations of rare plants and animals.

Shortly after Tyler joined the Service, she began working on recovery of the Spring Creek bladderpod (*Lesquerella perforata*), an endangered plant endemic to central Tennessee. Through her persistence, she pulled together a partnership among the Service, Tennes-

see State Heritage Program, the City of Lebanon, and two private companies (Cracker Barrel and TRW) to protect the few known populations of this species.

Tyler's work with the Barrens topminnow (*Fundulus julisia*) stands as a shining example of her hard work and dedication to the protection and recovery of rare species. This spring-dependent fish is endemic to south-central Tennessee; only two known populations remain, both on private lands. Working with the office's Partners Coordinator, a District Conservationist from the Natural Resources Conservation Service, and landowners, Tyler developed a conservation plan for this species that involved protection of the two known populations, propagation and augmentation, and reintroduction into historic sites.

Tyler's ability to establish partnerships was instrumental in her development of the first aquatic Habitat Conservation Plan (HCP) in the Southeast. The Nashville crayfish (*Orconectes shoupi*), an endangered species, is endemic to the Mill Creek watershed, which is located primarily within the boundaries of this rapidly growing city. Although it continues to exist in Mill Creek and its tributaries, the threats to this species are many. Tyler managed to bring a developer into partnership with the Service and metropolitan Nashville agencies to develop an HCP for protection of the Nashville crayfish. In addition to the HCP, Tyler worked with the City Parks Department on a Greenway development project that will further help protect the Nashville crayfish while

providing walkways and parks for the enjoyment of city residents.

Like any fish and wildlife biologist, Tyler loved to be out in the field, working directly with partners to protect the rare species with which she was entrusted. She would walk the stream bottoms in central Tennessee looking for Spring Creek bladderpod, walk high cliffhines to monitor populations of Cumberland sandwort (*Arenaria cumberlandensis*), or stand in the river passing slab rocks down the line to improve habitat for the boulder darter (*Etheostoma wapiti*). No matter how wet or muddy she got, there was always that beaming smile and words of encouragement for her colleagues.

The Service is diminished by the loss of Tyler Sykes. We will never know what she would have accomplished had she been able to stay with us and reach her full potential. But we do know that she was an inspiration to us. She showed us what hard work, dedication, and persistence can achieve. She has left a permanent mark on the trust resources of Tennessee and Kentucky, and we know that the rare species she worked with are better off for having been under her care. We will miss her.

Tyler leaves behind a husband, Robbie, two daughters, Chloe and Alley, and a host of friends and colleagues who miss her sorely. To contribute to a trust fund established for the Sykes children, you can send donations to: Sykes Children's Trust Fund, AmSouth Bank, 790 S. Jefferson Avenue, Cookeville, Tennessee 38501.



Tyler Alley Sykes
September 15, 1971 – May 14, 2002
Photo by Robert Sykes

Down by the Green River

by Robert S. Butler,
Richie Kessler,
and J. Brent Harrel



Above: a good example of riparian habitat, including a stand of native cane, near the mouth of Russell Creek.

Below: a relatively undisturbed bend of the Green River in Hart County.

Opposite page: Green River in Green County showing badly eroding banks.

All photos by Richie Kessler

\$110 Million Grant for Riparian Habitat

Representatives from the U.S. Department of Agriculture (USDA) and Kentucky Governor's Office recently signed a Conservation Reserve Enhancement Program (CREP) grant agreement. It allocates \$110 million of federal, state, and private funds to protect riparian areas in the upper Green River system. The USDA will provide \$88 million for this 10-year project, while the state and TNC contribute the matching \$22 million. Numerous agency and other partners, including staff from the Service's Asheville Field Office, were involved in crafting the grant proposal.

Row crops and livestock are in some cases detrimental to water quality and associated habitats. The CREP program's goal is to retire 100,000 acres

*I*mmortalized in John Prine's song "Paradise," the Green River flows lazily through west-central Kentucky before joining the Ohio River. Although Prine sings of the town of Paradise in Muhlenberg County, we think that true paradise lies many miles upstream.

The upper Green River system historically harbored 66 mussel species, or 22 percent of North America's mussel fauna, including the endemic Kentucky creekshell (*Villosa ortmanni*). Eight of these mussels and an endemic crustacean are listed under the Endangered Species Act. The river's fauna also includes records for 150 fishes, 8 of them system endemics. The Nature Conservancy (TNC) ranks the upper Green fourth nationally in number of imperiled aquatic species.

Located in a vast karst landscape, the upper Green's basin is dotted with at least 1,000 sinkholes and caves. The 336-mile (540-kilometer) Mammoth Cave system is the world's largest. The endangered Mammoth Cave shrimp (*Palaemonias ganteri*) is only found in the area's subterranean waters. Two endangered mammals, the gray bat (*Myotis grisescens*) and Indiana bat (*M. sodalis*), call caves in the region home.

The 100-mile (160-km) section of river between Green River Reservoir Dam (GRRD) and Mammoth Cave National Park is the focus for a major TNC community-based habitat restoration project. The primary goals of the Green River project,



which began in 1996, are to reduce nonpoint source pollution and eliminate other stresses on aquatic habitats. A project director, hired in 1999 to work in the mostly agricultural watershed, lives in the area and has become an accepted member of the community. The Fish and Wildlife Service's field offices in Asheville, North Carolina; Cookeville, Tennessee; and Frankfort, Kentucky, coordinate with TNC on restoration activities. Together, the Service and TNC are committed to the success of a long-term project and are establishing partnerships with landowners and other stakeholders in the region.

Typical habitat restoration activities include constructing fencing, providing alternate livestock watering sources, stabilizing heavy use areas, installing erosion control structures, revegetating streambanks, improving riparian buffers, and advocating improved agricultural practices. Community-based activities include illegal dump cleanups, providing low-cost rental equipment to community farmers, and hosting informational meetings. The eclectic approach to conservation benefits aquatic organisms by reducing sedimentation, nutrients, and other pollution runoff while enhancing riparian habitats for foraging bats and neotropical migratory birds.

Cooperators in the project include federal agencies (Environmental Protection Agency, Army Corps of Engineers, National Park Service, Geological Survey, Department of Agriculture's Natural Resources Conservation Service (NRCS) and Farm Services Agency), state agencies (State Nature Preserves Commission, Department of Fish and Wildlife Resources, and Divisions of Water, Conservation, and Forestry), private landowners, and other stakeholders.

The partners are tapping various funding sources for restoration activities. The Service's Partners for Fish and Wildlife program is aiding private landowners in restoring riparian buffers and related activities. TNC has an excellent track record in leveraging "seed money" many times over with private

and other funds. Clean Water Act grants help fund various restoration activities and other expenses. Habitat protection programs of NRCS, such as the Environmental Quality Incentives Program and Conservation Reserve Enhancement Program (see sidebar article), are also commonly used by farmers.

Scientific research activities in the system are shedding light on how to better manage, conserve, and recover the Green's imperiled fauna. The Corps of Engineers has been contracted by TNC to modify releases from GRRD to better meet the needs of aquatic resources. A mussel propagation facility is being considered by Mammoth Cave National Park. Research in the watershed being conducted on imperiled fishes, crayfishes, and mussels not only furthers our knowledge of these organisms and aids in their recovery, it helps partners identify stream reaches critical for protecting and managing important habitats.

The community-based approach proves that farming and natural resource conservation are compatible, economically feasible, and highly desirable for all parties (and species) involved. Private landowner cooperation is the most crucial variable in the habitat protection equation. Without broad-based landowner support, restoration efforts would have little chance of success. With their support, we can improve and protect the stream and riparian habitats upon which the imperiled wildlife of the Green River fauna depends.

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(40,400 hectares) of stream and sinkhole riparian areas from agricultural production. Private landowners in eight counties may be involved. The ambitious, but voluntary, incentive-based program pays eligible landowners bonuses of \$140 to \$150 per acre for signing 15-year buffer agreements and annual payments of \$80 to \$150 per acre for maintaining buffers, while permanent easements will earn landowners \$400 per acre, funded by TNC.

Money from CREP will dovetail nicely with TNC's Green River Bioreserve. TNC will continue to use Service and other restoration funds to continue riparian restoration work, while CREP funding will go only toward habitat protection. Together, the two funding sources should ensure that significant portions of Green River riparian habitats are restored and protected.

by Ken Burton

Sending Surrogates to the Rescue



Artificially-propagated juvenile wavy-rayed lampmussels

Photo by Richard Neves/U.S. Geological Survey

*I*t is reclusive, silent, and sedentary, but it's also Mother Nature's natural water filter and an indicator species to boot, and now a small group of scientists in the Southeast is putting in long hours in an attempt to rescue a single imperiled species of mussel.

The road back, says Dr. Jim Layzer, of the Tennessee Cooperative Fishery Research Unit, means putting a mussel back in part of its historic range and seeing it thrive, to the point where the species won't have to remain on the endangered species list.

"Recolonization is an extremely delicate process," says Layzer, who spends a lot of his time working with other researchers to find the key that will get a mussel through its first growing season. Layzer says, with delight, "We are having great success."

Layzer's efforts are aimed at reviving the population of endangered Cumberland bean (*Villosa trabalis*) mussels, originally found in the Tennessee and Cumberland River drainages.

Like most other mussels in trouble, these can trace some of their problems back to the early twentieth century. Pollution played a role, and so did the effects of agriculture, logging, and dams.

The plight of the freshwater mussel is neither a regional nor a small problem. Seventy-two species of mussels throughout the United States are already classified as threatened or endangered, and dozens more species may be headed in the same direction.

A central piece of the puzzle, says Layzer—who is part of an effort supported by the state of Tennessee, Tennessee Tech University, the Biological Research Division of the U.S. Geologic

Survey and two U.S. Fish and Wildlife Service fish hatcheries, Dale Hollow in Tennessee and Wolf Creek in Kentucky—is how to nurture juvenile mussels beyond the critical first 2 to 4 months.

"We need to grow them to maturity," Layzer says, "and when we can get them to that point, we can reintroduce them in quantity." Both hatcheries have encountered problems keeping young mussels alive for prolonged periods, but survival after 60 days usually indicates that the mussels are meeting their nutritional requirements.

Layzer and his researchers have collected and reproduced the wavy-rayed lampmussel (*Lampsilis fasciola*), which is also found in the same river drainages as the Cumberland bean, and used it as a substitute for testing reintroduction techniques since it isn't endangered. If the lampmussels survive reintroduction, then there is good hope for the Cumberland bean. If the lampmussels don't survive, none of the endangered mussels have been lost.

"If the mussel population is in trouble, that can be a signal that other things are wrong," says Andrew Currie, who manages the Wolf Creek and Dale Hollow hatcheries. Currie and Layzer both agree: a decline in the mussel population could not only affect water quality—they are Mother Nature's natural water filters—but their absence can also indicate that something more is amiss.

Mussels are capable of ingesting pesticides or heavy metals, but only to a point. Accumulated in heavy doses, those toxins can then become threats to other animals that depend on mussels as part of their diet. That can warn of danger to people who depend the rivers for drinking water.

Mussels can signal environmental changes in other ways. Many mussel species depend on specific species of fish to serve as hosts for mussel larvae, or glochidia. If dams reduce a fish's habitat, a declining mussel population could be the result.

Layzer believes that mussels are valuable but, because they are not fully understood, no one is able to fully appreciate their ecological contributions to our world.

"We're destroying or wiping out species before we know what their value might be," Layzer says. "That in itself should justify the time and expense that it takes to help them avert extinction. Beyond that, we have an ethical obligation to all the species that share this planet."

When we lose anything we don't fully understand, we're really losing a figurative encyclopedia. And we might be losing a page with enormous beneficial effects for mankind."

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Cumberland bean mussel

Photo by Richard Biggins/USFWS



Cryptic Biodiversity

by Robert S. Butler and
Richard L. Mayden

Just how many aquatic animal species do we have in the Southeast? We don't have a final answer to this question yet, but through the collaborative efforts of agency biologists and scientists specializing in taxonomic classification, we are moving in the right direction. We do know that the southeastern United States harbors the greatest level of temperate zone aquatic biodiversity in the world. For creatures such as freshwater mussels, the most highly imperiled animal group in the U.S., the level of diversity exceeds that of any other region globally.

Researchers in systematic biology continue to learn about the biological diversity of this region, some of which is referred to as "cryptic" or unknown biodiversity. The discovery of formerly unrecognized species has been made possible by the development of sophisticated analytical tools. Advances in both technology and theory in systematic and evolutionary biology have permitted scientists to detect additional species diversity around the world on the basis of divergences in genetic, morphological (body form), ecological, and behavioral traits that were previously unknown.

Most biologists with a knowledge of aquatic organisms are familiar with species "complexes." Generally, a species complex describes a relatively wide-ranging species that has an unusual distribution or is highly variable across its range in morphological characters, habitat preferences, or other aspects of its anatomy, life history, or ecology. This understanding is rapidly changing. Species are now considered evolutionary lineages, and these lineages are identified using a variety of heritable traits that can have differing degrees of differentiation within and between groups. Scientists are incorporating various types of data into their studies to reveal naturally occurring patterns of diversity. Accurate

knowledge of diversity is not only critical to scientists seeking to understand processes responsible for biological diversification, but is equally critical to resource managers hoping to develop effective conservation programs.

Over the past decade or two, thorough studies of the morphological, behavioral, ecological, and genetic variation in species have resulted in the "splitting" of several fairly well-known polytypic (containing populations that have different morphological traits) species into numerous "new" species. Two recent changes that have been important in refining this science include the technological advances in molecular genetics and a more pronounced emphasis on field studies with the examination of live organisms.

Historically, morphological data obtained from preserved museum specimens was the primary source of characters used in differentiating new taxa. Museum materials are essential, but often they do not readily reveal important characteristics found in cryptic species complexes. These types of traits are best found by examining live specimens or by using other methods useful in identifying evolutionary lineages, such as genetic traits. Following the identification of new taxa, all of the

evidence, whether it is genetic, morphological, behavioral, ecological, or combinations thereof, is compiled into a formal species description for publication in a peer-reviewed scientific journal.

Several recent examples among the fishes show how the use of genetic and morphological data, combined with phylogenetics (genetic relationships of related organisms) systematics and a revolutionized theory of how species are determined, has improved our understanding of diverse biological lineages. The greenbreast darter (*Etheostoma jordani*) was long thought to consist of a single species found in most of the major rivers of the highly rich Mobile Basin. A thorough evaluation of the variation in this species based on live and museum specimens revealed four distinct species, one of which, the Etowah darter (*Etheostoma etowahae*), is now listed as endangered. As its name indicates, this fish is endemic to the Etowah River in the upper Coosa River Basin (see plate 1). The speckled chub (*Macrhybopsis aestivalis*) complex was long considered a wide-ranging polytypic species with six subspecies. Now, this "species" is known to contain at least 10 genetically and morphologically distinct species, some of which are likely imperiled (see plate 2). Numerous other fish species



complexes are known. In fact, a recent compilation of the status of all native southern freshwater fishes led to an estimate that approximately 10 percent of the 662 known taxa are formally undescribed (Warren et al. 2000).

High levels of cryptic biodiversity probably also exist for certain other aquatic groups that warrant more thorough systematic evaluations. Few mollusk or crayfish biologists are systematists and taxonomists, making it very difficult to know if our inventories of understudied groups reflect natural diversity. But the number of taxa described in these poorly known groups is considered artificially low by conservationists. Numerous additional taxa are presumed to occur in the Southeast.

The rich aquatic biodiversity of the southeastern U.S. is attributable to various geological and zoogeographic (geographic distribution of animals) factors. The Southeast is an ancient and highly diverse landscape over half a billion years in age and is composed of numerous physiographic provinces (major land area classifications based on geology and geographic features). Each province has a distinct lithography, or mineral composition, which influences the chemistry of surface and ground waters. Southeastern waters receive

abundant rainfall and display a diverse array of habitat types. Differentiation of species also has been fostered by the Southeast's stable geologic history. None of the streams draining upland areas of the Southeast were glaciated during Pleistocene ice ages or inundated by Cretaceous seas during interglacial periods. These upland areas have served as the primary "spawning sites" for the evolution of various new aquatic species. Unlike birds and mammals, most freshwater organisms have physical barriers (e.g., waterfalls, relatively abrupt changes in water or substrate quality, marine waters) to their dispersal; therefore, they are often endemic to discrete watersheds or regions.

Plotting species distributions on drainage maps with GIS (geographic information systems) technology is aiding researchers in identifying species that may represent complexes of diversity. A characteristic distribution pattern for many aquatic species complexes has been physiographic integrity. Although many currently recognized complexes are found in several physiographic provinces, some forms are found to be endemic to a particular province, group of provinces, or possibly to the transition region between adjacent provinces. Others may be found in a single river

Plate 1. Newly discovered and described species in the *Etheostoma jordani* complex. Clockwise from upper left: *Greenbreast darter* (*Etheostoma jordani*), *Tuskaloosa darter* (*Etheostoma douglasi*), *Lipstick darter* (*Etheostoma chuckwachattee*), *Etowah darter* (*Etheostoma etowahae*).

Illustrations © Joseph Tomelleri

system, or in the extreme from a single spring. For instance, the pygmy sculpin (*Cottus paulus*) is known only from Coldwater Spring, part of the Coosa River system of northeast Alabama. Species with normally disjunct distributions or widely separated populations may also indicate that more than one taxonomic entity is represented.

Another clue for potential cryptic biodiversity may be when populations in one portion of a species' range are doing well while populations in another region are disappearing. The frecklebelly madtom (*Noturus munitus*) complex, until recently considered a single species, represents an excellent example. The undescribed madtom species in the upper Coosa River system is highly imperiled and is disappearing from one of the two major watersheds it occurs in, whereas the lowland form of frecklebelly madtom is relatively common in major river systems below the fall line where it is endemic. The best pyramid pigtoe (*Pleurobema rubrum*) populations

remaining occur in Arkansas, while all populations east of the Mississippi River are highly imperiled. This mussel should be investigated to determine if it represents a species complex.

Some of the complexes of species being sorted out taxonomically are already relatively rare. In addition to the greenbreast darter example above, the vermilion darter (*Etbeostoma chermocki*) group illustrates cryptic diversity and disjunctions of imperiled taxa. When the vermilion darter, now a federally listed species, was discovered a thorough analysis of presumed close relatives revealed three undescribed and disjunct relatives. One of these species was later described as the Warrior darter (*E. bellator*). The other two, both considered imperiled by Warren et al. (2000), await formal taxonomic description.

The general lack of critically needed resources needed to delineate new taxa continues to hamper species assessments and listing activities. This has resulted in various elements of biodiversity becoming increasingly rare. Consequently, an increasing number of aquatic organisms that serve as natural resources for human

populations and indicators of the state of our environment will be “circling the drain,” inevitably spiraling toward extinction. In some cases, these organisms will not have been formally described or even recognized as distinct before they disappear. Only through increased awareness by the public and governmental agencies and a proportional increase in resources can we curb this loss of biodiversity.

Because of the forethought of concerned academicians, agency biologists, and others, there is a ray of hope. Recovery plans and recently penned strategies to protect imperiled faunas—specifically North American mussels and southeastern fishes—make the search for cryptic biodiversity a high priority task. Working groups, such as the Upper Coosa River Basin Aquatics Summit, meet regularly to discuss newly discovered taxa, their threats, and conservation strategies. Resource managers are tackling the imperiled cryptic biodiversity issue by allocating funding for molecular genetic and morphometric studies of presumed complexes.

By working together in innovative ways, elected officials, budgetary administrators, resource conservation managers, and researchers in academia can turn the tide of increasing imperilment and protect the vast richness of biodiversity hidden within our southeastern waters.

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Plate 2. Five undescribed species of the *Macrhybopsis aestivalis* species complex found in rivers of the southeastern United States.

Sturgeon Surveys in the Lower Mississippi River

by Paul Hartfield

*I*n September 2001, the Fish and Wildlife Service's Jackson Field Office and the Mississippi Museum of Natural Science, with assistance from the Lower Mississippi River Conservation Commission, initiated a multi-year program of trawl surveys for sturgeon in the lower Mississippi River. A trawl is a large fishing net that is towed along the bottom of the river. The trawl surveys are being used to identify pallid sturgeon (*Scaphirhynchus albus*) and shovelnose sturgeon (*Scaphirhynchus platorynchus*) habitat use over a range of river stages and conditions in the vicinity of Vicksburg, Mississippi.

In 20 days during September-November of 2001, we made 5 to 17 trawl pulls per day, with an average pull time of about 10 minutes. Eleven pallids (endangered) and 376 shovelnose (nonlisted) were collected. Extended high spring and early summer river stages limited sampling in 2002 to 11 days, with 2 to 18 pulls per day. This year, 5 pallids and 239 shovelnose were collected. We hope to continue our surveys for at least another year.

One of our objectives has been to determine the value and efficiency of trawl surveys for sampling sturgeon and other big river fishes. Fortunately, we've found trawling to be effective for sampling shovelnose and pallid sturgeon in the lower Mississippi, although it is somewhat limited at depths below 40 feet (12 m). All sturgeons captured have been associated with moderate to strong currents, depths of 13 to 45 feet (4 to 14 m), a sand or sand and gravel substratum, and structure in the form of sand reefs, dunes, or secondary channels. Pallid captures seem to be associated



Pallid sturgeon

Photo by Jim Rathert/USFWS

with greater depths, ranging from 25 to 45 feet (7.5 to 14 m).

The 2001 surveys were conducted by Paul Hartfield of the Service's Jackson Field Office (601/321-1125, paul_hartfield@fws.gov); Daniel J. Drennen, also of the Service's Jackson Office (601/321-1127, daniel_drennen@fws.gov); Dr. Todd Slack of the Mississippi Museum of Natural Science in Jackson (601/354-7303, todd.slack@mmns.state.ms.us); and Ron Nassar of the Lower Mississippi River Conservation Commission (601/629-6602, ron_nassar@fws.gov).

Paul Hartfield is a wildlife Biologist in the Service's Jackson Field Office (601/321-1125, paul_hartfield@fws.gov)



The Mississippi river, in the vicinity of Vicksburg, Mississippi, was the site of sturgeon surveys.

by Michael Kreger and
Patricia L. Ford

Chinese Biologists Compare Argali to Bighorn

“Stop the car!” cried Liu Chuguang through our interpreter, Julia Su. The minibus slid to a halt on the rocky washboard road. As the dust cleared, we made out a thin tawny figure picking its way around a field of boulders. Then, about 50 feet (15 meters) away, an adult female desert bighorn sheep, a yearling, and a lamb came into view. We were visiting the Hualapai Indian Reservation in northern Arizona at the base of the Grand Canyon, a special place for us and for our colleagues from China. Seeing a desert bighorn sheep in the wild was as exciting for them as seeing the endangered argali (a large Asian bighorn sheep) had been for us when we had the opportunity to visit China the previous year.



The delegation from China was thrilled to see bighorn sheep (top and right) on their U.S. tour.
USFWS photos above; photo at right by Corel Corp.

The visit of five Chinese delegates was coordinated by the Service's International Affairs program, which implements the "Nature Conservation Protocol Between the State Forestry Administration of the People's Republic of China and the Department of the Interior." As part of the agreement, the United States sent biologists to China in 2001 to learn about argali (*Ovis ammon*) management. In return, we spent two weeks with the Chinese delegation, first in Arizona, home of the desert bighorn (*Ovis canadensis arizonae*), and then in Montana, home of the Rocky Mountain bighorn (*Ovis canadensis*). In both states, the Chinese delegation met with scientists, managers, and researchers who work together to manage these marvelous animals at the federal, state, and tribal levels.

At their peak, desert bighorn sheep in North America may have numbered more than 2 million animals, but competition with livestock in the 1800s reduced the population to approximately 20,000, of which 4,500 are found in Arizona. Representatives from Arizona Game and Fish Department, the Phoenix Zoo, and the Hualapai Reservation introduced the delegation to Arizona wildlife, discussed methods of estimating population sizes, and provided information on predation, disease, and nutrition. The delegation also learned that, on occasion, when bighorn from the reservation cross into Grand Canyon National Park, and vice versa, the three governments coordinate material or technical assistance.

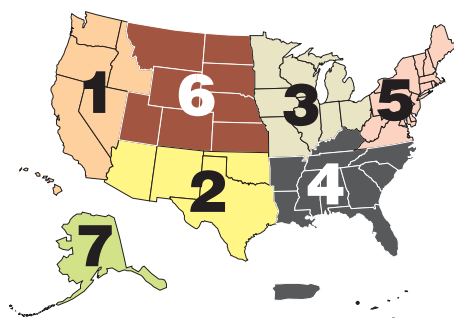
Rocky Mountain bighorn sheep populations in the contiguous United States also declined by the early 1900s due to commercial exploitation, habitat loss, and competition and diseases from domestic livestock. Then, in the 1940s and 1950s, state wildlife management agencies began reintroducing bighorns to their historic range, using animals from the remaining stocks and herds from Canada. Now, Rocky Mountain bighorn sheep are widely distributed throughout the Rocky Mountain states and south into New Mexico, with an estimated population of more than 19,000 in 1985. In Montana, the Chinese delegates learned about these animals from University of Montana researchers, Forest Service and Fish and Wildlife Service biologists, and staff from the Montana Department of Fish, Wildlife and Parks, who described such tools as prescribed fire and the reintroduction of bighorn sheep to manage wildlife resources. They learned about Montana's hunting laws, as well as regulations covering the sheep. In addition, they visited a

taxidermist who instructed them in the science of preserving lifelike specimens. Of particular interest was a demonstration that involved permanently marking legally hunted trophy heads to discourage poaching.

Our visitors saw spectacular wildlife and habitat, took copious notes, shot many rolls of film, and asked insightful questions. They received information that may improve their ability to manage their own wild sheep populations. In addition, U.S. and Chinese biologists formed strong bonds of friendship that likely will benefit both nations.

Michael Kreger and Patricia L. Ford are biologists with the Service's Division of Scientific Authority in the International Affairs program.





Regional endangered species staffers have reported the following news:

Region 1

Ash Meadows National Wildlife Refuge In April 2002, volunteers donated over 200 hours to restore native plants at Ash Meadows National Wildlife Refuge (NWR) in Nevada. By working to revegetate the site, volunteers helped restore and recreate historical habitat in a system of springs and outflows called Point of Rocks for the endangered Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*) and the threatened Amargosa naucorid (*Ambrysus amargosus*), an aquatic insect.

Established in 1984, the refuge includes a total of 23,928 acres (9,683 hectares) of spring-fed wetlands and alkaline desert uplands. Ash Meadows NWR provides habitat for at least 24 plants and animals that occur only within the boundaries of the refuge. Twelve of those endemic species are listed as threatened or endangered under the Endangered Species Act (ESA).

San Pablo Bay NWR The refuge began the restoration of 72 acres (29 ha) of low-yield hayfields to tidal salt marsh last March by breaching a bayfront levee. The goal is to bring back native pickleweed-dominated vegetation, which is habitat for the salt marsh harvest mouse (*Reithrodontomys raviventris*) and California clapper rail (*Rallus longirostris obsoletus*), two endangered species in the greater San Francisco Bay estuary. The restoration site included lands managed by the refuge under long-term lease from State of California Lands Commission. This site is situated immediately east of and adjacent



California clapper rail

photo by Mike Boyland/USFWS



Salt marsh harvest mouse

Photo © B. Moose Peterson/WRP

to the Tolay Creek Unit of the refuge, a 435-acre (177-ha) site restored to tidal action in December 1998 for the same purposes.

Region 5

American burying beetle (*Nicrophorus americanus*) Reintroduction of this carrion beetle continues on Nantucket Island, off the coast of Massachusetts. The Roger Williams Park Zoo in Providence, Rhode Island, has reared beetles for release since 1994. Last June, the largest effort to date occurred with over 270 pairs released at the Massachusetts Audubon Society's Sesachacha Wildlife Sanctuary and Ram Pasture (owned by the Nantucket Conservation Foundation). Each pair was supplied a quail carcass to provide food for the adults and future larvae. National Public Radio was on hand to obtain information for its "Living on Earth" program. Partners essential to the success of this work include the Zoo, Massachusetts Audubon, Nantucket Conservation Fund,

Maria Mitchell Natural History Museum, Massachusetts Division of Fisheries and Wildlife, and the Service's New England Field Office.

Lee County Cave Isopod (*Lirceus usdagalun*) On February 19, 2002, five staff from the Service and the Virginia Department of Conservation and Recreation's Division of Natural Heritage rediscovered the Lee County cave isopod in Thompson Cedar Cave, where the tiny crustacean was thought to be extirpated. The Lee County cave isopod was listed as endangered in 1992 and is known from only the Thompson Cedar Cave type locality and one other cave and two springs located in the unique limestone karst topography of southwestern Virginia.

The isopod population and the cave wildlife community were thought to be extirpated from Thompson Cedar Cave by 1988 due to leachate from a huge sawdust pile that was deposited in and around the cave entrance. In response to concern from the Service and several state agencies, the sawmill operator voluntarily removed the sawdust from the sinkhole surrounding the cave entrance and installed a clay berm to divert surface runoff from the sinkhole. According to an inventory conducted in late June by biologists from the Service and the state Division of Natural Heritage, the Lee County cave isopod population in Thompson Cedar Cave is growing and the remaining ecological community of the cave seems to be thriving. We believe that the removal of the sawdust from the sinkhole surrounding the cave entrance and recent drought conditions have slowed the release of leachate to the subterranean system, allowing the cave community to recover. The Service and several partners are assisting the lumber company in removing the remaining sawdust.

Piping plover (*Charadrius melodus*) U.S. Atlantic Coast piping plover abundance and productivity figures for the 2000 and 2001 breeding seasons are now available on-line at "<http://pipingplover.fws.gov/status/index.html>." After a 3 percent decline between 1997 and 1999, the estimate of breeding pairs on the U.S. Atlantic Coast posted a 4 percent increase between 1999 and 2000, followed by a 6 percent gain in 2001. The total 2001 U.S. Atlantic count of 1,280 breed-



Piping plover

Photo © Richard Kuzminski

ing pairs is the highest since the species' 1986 listing under the ESA. Increases occurred in all three U.S. Atlantic recovery units, with the largest percentage gains in New York-New Jersey. The Atlantic Canada population also posted a 16-year high estimate of 245 pairs. Net change in the entire Atlantic Coast population over the two years 2000-2001 was more than 9 percent, for a total of 1525 pairs nesting between North Carolina and Newfoundland.

The Service's Long Island Field Office (LIFO) continues to make strides in protecting the piping plover on privately held lands and lands managed by federal, state, and local governmental agencies. The LIFO has worked with these entities to promote and implement predator trapping, education and outreach programs, training, and on-the-ground technical and logistical assistance. Over the course of two weeks in June of this year, the LIFO met with representatives from four communities, the National Park Service, a local town, four fire districts, two police districts, and multiple utility companies to draft a plan to protect breeding plovers within the National Park Service's Fire Island National Seashore from adverse impacts due to off-road vehicles, pedestrians, pets, and fireworks. As part of this effort, the Service will provide training to local community members interested in monitoring the plover nests and chicks, technical assistance to the governing town in the drafting of local executive orders to protect plovers, and assistance to the National Park Service during the ESA-section 7 consultation process in developing the final plan to avoid adverse impacts to the species.

From February through October 2002, we published the following Endangered Species Act (ESA) rules in the *Federal Register*. The full text of each action can be accessed through our website: <http://endangered.fws.gov>.

Emergency Listing Rule

California Tiger Salamander (*Ambystoma californiense*) On July 22, due to an imminent threat of habitat destruction, we listed the Sonoma County distinct population segment of the California tiger salamander as endangered under the emergency provisions of the ESA. This action gave temporary but immediate protection to the salamander and its habitat. The emergency listing will remain in effect for 240 days, while we make a final decision on a proposal to give the Sonoma County population of California tiger salamander long-term protection under the normal listing process. (This proposal also was published in the July 22 *Federal Register*.)



California tiger salamander

Photo © B. Moose Peterson/WRP

Urban development is the primary and imminent threat to the remaining seven breeding sites of the Sonoma County tiger salamander population. The animal now occurs in scattered and increasingly isolated breeding sites within a small portion of its historic range in Sonoma County. Four breeding sites have been destroyed or significantly degraded within the last 2 years. All of the remaining breeding sites are distributed in the city of Santa Rosa and associated unincorporated areas on the Santa Rosa Plain. The Sonoma County population is geographically isolated and separate from other populations of this species.

The California tiger salamander is a large and stocky amphibian with a broad, rounded snout.

Males may reach about eight inches (20 centimeters) in length; females are slightly shorter. They have white or pale yellow spots or bars on a black background. Their undersides can vary from almost uniform white or pale yellow to a varying pattern of white or pale yellow and black.

California tiger salamanders make use of burrows created by small mammals, especially ground squirrels and pocket gophers. Adult tiger salamanders spend an average of six to nine months per year in the burrows, where they await the arrival of fall or winter rains. The loss of burrow systems is a significant threat to the survival of the California tiger salamander.

Proposed Listing Rules

Gila chub (*Gila intermedia*) On August 9, we proposed to list this southwestern fish as an endangered species. The Gila chub is a small, darkly colored fish that reaches a length of about 6 to 8 inches (15 to 20 cm). It was once found throughout small streams, springs, and pools in the Gila River basin in southern Arizona, southwestern New Mexico, and northeastern Sonora, Mexico, but it has been extirpated or reduced in numbers and distribution in most of its historical range. We estimate that 85 to 90 percent of the Gila chub's habitat has been degraded or destroyed. Where this fish still occurs, populations are often small, scattered, and at risk of extirpation. The listing proposal included a proposal to designate seven stream areas of about 208 miles (333 kilometers) in total length as critical habitat for the chub.



Gila chub

USFWS photo

Threats to the remaining populations include: 1) predation by, and competition with, nonnative organisms, including other fish species, bullfrogs

(*Rana catesbeiana*), and crayfish (*Orconectes virilis*); 2) disease; and 3) habitat alteration, destruction, and fragmentation resulting from water diversions, dredging, recreation, roads, livestock grazing, changes in the natural flow pattern, mining, degraded water quality (including contaminants from mining activities and excessive sedimentation), and groundwater pumping.

Beluga Sturgeon (*Huso huso*) We proposed on July 31 to list the beluga sturgeon as an endangered species. This large fish inhabits the Caspian and Black Seas, and it spawns in the rivers that constitute the drainage basins of these seas. Loss



Beluga sturgeon

Photo by Hans-Jurgen Burkard/Bilderbert
Photo courtesy of Caviar Emptor

of habitat throughout historic spawning areas due to dam construction and river-modification projects, overharvest for the international caviar trade, widespread poaching and illegal trade to supply the caviar market, and pollution imperil the survival of this species. Due to continuing overharvest, the greatest threat, this species was listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1998. Despite the CITES listing, beluga sturgeon populations have continued to decline, and the population structure is increasingly skewed towards subadult fish, with a critical lack of spawning-age adult female fish. If this species is listed as endangered under the ESA, commercial imports, exports, re-exports and interstate commerce of beluga sturgeon (including its caviar) would be prohibited.

California Tiger Salamander (*Ambystoma californiense*) As mentioned previously, we

proposed on July 22 to make permanent the provisions of the emergency rule listing the Sonoma County distinct population segment of the California tiger salamander as endangered. This population is currently known from only seven viable breeding sites and associated uplands.

Slickspot Peppergrass (*Lepidium papilliferum*) On July 15, we proposed to list this rare plant, an annual or biennial in the mustard family (Brassicaceae), as endangered. It occurs only in sagebrush-steppe habitats in southwestern Idaho, including the Snake River Plain, Owyhee Plateau, and adjacent foothills.

The slickspot peppergrass ranges from 4 to 12 inches (10 to 30 cm) in height. It has many tiny white flowers and most closely resembles the garden flower sweet alyssum. As its common name indicates, the slickspot peppergrass typically grows in small areas known as “slick spots” that are within large sagebrush areas. Slickspots are inclusions of clay or alkaline soils within a larger matrix of saline soils. These smaller sites are often lower than the surrounding areas, so they retain water longer than the surrounding soil. These areas may be as small as a square foot or as large as half a basketball court. They usually are surrounded by big sagebrush, native bunchgrasses, wildflowers, mosses, and lichens.

Biologists have documented 70 occurrences of slickspot peppergrass in Ada, Canyon, Gem, Elmore, Payette and Owyhee counties, but only six of these areas are considered to be of high quality. This species is no longer found in 18 other historic sites. The remaining suitable habitat to support this species is less than 12,400 acres (520 hectares).

All remaining populations of the slickspot peppergrass are potentially vulnerable to naturally occurring events (such as wildfire), introductions of exotic species, development, and other human activities.

Three Southwestern Aquatic Invertebrates We proposed on February 12 to list the Roswell springsnail (*Pyrgulopsis roswellensis*), Koster's tryonia (*Tryonia kosteri*), Pecos assiminea

(*Assiminea pecos*), and Noel's amphipod (*Gammarus desperatus*) as endangered species and to designate their critical habitat. These species occur at sinkholes, springs, and associated spring runs and wetland habitats. They are found at two sites in Chaves County, New Mexico, one site in Pecos County, Texas, and one site in Reeves County, Texas. *Pecos assiminea* is also known from one area in Coahuila, Mexico.

These small aquatic animals have an exceedingly limited distribution and are imperiled by local and regional groundwater depletion, surface and groundwater contamination, oil and gas extraction activities within the supporting aquifer and watershed, and direct loss of their habitat (e.g., through burning or removing marsh vegetation, cementing, or filling of habitat).

Roswell springsnail, Koster's tryonia and Pecos assiminea are small aquatic snails, while the Noel's amphipod is a freshwater shrimp. The species coexist in small, geographically isolated springs at Bitter Lake National Wildlife Refuge in Chaves County in southeastern New Mexico. The Pecos assiminea snail also occurs at Diamond Y Springs in Pecos County and East Sandia Spring in Reeves County, on land managed by the Nature Conservancy of Texas.

Final Listing Rules

Tumbling Creek Cavesnail (*Antrobia culveri*) We published a final rule on August 14 listing this small aquatic snail as an endangered species. It is known to occur only in one



Tumbling Creek cavesnail

USFWS photo

cave in Missouri, and its distribution has decreased by 90 percent since 1974. Although cavesnail numbers fluctuated seasonally and annually between 1996 and 2000, the species was not found in the monitored section of the cave stream during six surveys in 2001 and two surveys in 2002. Small numbers of individuals continue to exist in other portions of the cave stream. Because the sudden population decline demonstrates a significant and imminent risk to the well-being of the Tumbling Creek cavesnail, we found that listing this species was necessary.

Carson Wandering Skipper (*Pseudocopaeodes eunus obscurus*) We listed this small butterfly on August 7 as endangered. The Carson wandering skipper is currently known from only two populations, one in Washoe County, Nevada, and one in Lassen County, California. The subspecies is found in grassland habitats on alkaline substrates. It is threatened by habitat destruction, degradation, and fragmentation due to urban and residential development, wetland habitat modification, agricultural practices (such as excessive livestock grazing), gas and geothermal development, and nonnative plant invasion. Other threats include collecting, livestock trampling, water exportation projects, road construction, recreation, and pesticide drift.



Carson wandering skipper
USFWS photo

Mountain Yellow-legged Frog (*Rana muscosa*) The southern California distinct population segment of the mountain yellow-legged frog was listed July 2 as endangered. Seven small, isolated populations totaling fewer than 100 adult individuals are believed to exist within portions of the San Gabriel, San Bernardino, and San Jacinto Mountains. Historically, the southern California population was known from about 166 documented localities ranging from Palomar

Mountain in northern San Diego County to the San Gabriel Mountains in Los Angeles County.

Although the exact causes of the California population's dramatic decline are not fully understood, possible causes include predation from bullfrogs and introduced trout, disease, contaminants, and habitat alteration. Almost all of the remaining populations of mountain yellow-legged frogs in southern California are confined to a few stream reaches within the boundaries of the Angeles and San Bernardino national forests.

San Diego Ambrosia (*Ambrosia pumila*) Also on July 2, we listed this rare plant in the sunflower family (Asteraceae), which is found in southern California and northern Baja California in Mexico, as endangered.

Once found on 40 distinct sites in San Diego and Riverside counties, occurrences of San Diego ambrosia in the United States are now restricted to 12 sites in San Diego County and three in Riverside County. The Service has worked for several years prior to listing with the city and county of San Diego and Riverside County to protect the San Diego ambrosia wherever it occurs.

The species is threatened by 1) habitat loss, fragmentation, and degradation from urban and recreational development; 2) highway construction and maintenance activities; 3) trampling and soil compaction from horses, humans, and vehicles; 4) maintenance of utility easements; and 5) introduction of non-native plants.



San Diego ambrosia
USFWS photo

Chiricahua Leopard Frog (*Rana chiricahuensis*) This species of frog has been eliminated from more than 75 percent of its historical sites and numerous mountain ranges, valleys, and drainages within its former range. In areas where it is still present, populations are often small, widely scattered, and occupy marginal and dynamic habitats. Known threats include habitat alteration, destruction, and fragmentation, predation by nonnative organisms, and disease. The June 13 final listing rule will give federal protection to this species and provide funding for developing and implementing recovery actions. Concurrently with publication of the final rule, we are publishing a special rule under section 4(d) of the ESA. Under the special rule, take of Chiricahua leopard frog caused by livestock use of, or maintenance activities at, livestock tanks located on private, state, or tribal lands would be exempt from the "take" prohibitions in section 9 of the ESA.

Desert Yellowhead (*Yermo xanthocephalus*) On March 14, we listed the desert yellowhead, a perennial herb in the sunflower family, as a threatened species. The only known population, which included approximately 12,000 plants according to surveys conducted in 2001, exists on less than 50 acres (20 ha) of public property administered by the Bureau of Land Management (BLM) in southern Fremont County,



Desert yellowhead
Photo by Chuck Davis/USFWS

Wyoming. Its restricted range and small population size make this plant vulnerable to extinction by natural and human-caused disturbance and environmental stress. Potential oil and gas field development on a 1,160-acre (470-ha) lease that includes the plant's habitat is one threat to the species. Two large leases for oil and gas development were issued in 1996 and 1997 that could impact the plant and its habitat, with no specific stipulations included to protect the plant. The Service is working with the BLM to develop a conservation agreement.

Buena Vista Lake Shrew (*Sorex ornatus relictus*) On March 6, we listed the Buena Vista Lake shrew, a tiny insect-eating mammal native to California's southern San Joaquin Valley, as endangered. This unique animal, which consumes more than its weight in insects every day, is part of the San Joaquin Valley's historic ecosystem. With scientific surveys unearthing fewer than 30 of these animals at only four locations—the former Kern Lake Preserve, Cole Levee Ecological Preserve, the Kern Fan recharge area and our own Kern National Wildlife Refuge complex—we believe the species is perilously close to extinction.

Biologists believe the Buena Vista Lake shrew has lost more than 95 percent of its historic habitat. The remaining populations are threatened primarily by agricultural activities, modifications of local hydrology, uncertain water supply, possible toxic effects from selenium poisoning, and naturally occurring catastrophic events such as drought that could wipe out the remaining animals. Water is a vital component of the shrew's environment because of the moisture required to support the variety of insects that are its primary food source.

Showy Stickseed (*Hackelia venusta*) Considered the state of Washington's rarest plant, this species was listed on February 6 as endangered. The showy stickseed has a beautiful, five-lobed, white flower and is known from only one location in Chelan County on U.S. Forest Service land. Past surveys show the stickseed has been moving steadily towards extinction, having declined from more than 1,200 individuals in the early 1980s to about 500 plants in 2001.



Showy stickseed

Photo by Ted Thomas/USFWS

The stickseed is threatened primarily by collectors who desire the plant because of its rarity. It grows on fine, loose granite slopes containing little organic matter, and, as a result, few nutrients. Several nonnative noxious weeds have invaded stickseed habitat and threaten to out-compete the stickseed for the available nutrients. Habitat disturbance also threatens the stickseed, as does competition from native and nonnative plant species caused by fire suppression, which leads to vegetational succession.

Delisting Rules

Robbins' Cinquefoil (*Potentilla robbinsiana*) Celebrating the recovery of the Robbins' cinquefoil, a small alpine perennial herb in the rose family (Rosaceae), we published a final rule on August 27 removing this plant from the list of endangered and threatened species. Its main population contains more than 14,000 plants, and the 2 transplant populations have reached or surpassed their minimum viable population size.

The Robbins' cinquefoil is endemic to a harsh alpine environment in the White Mountain National Forest of New Hampshire. Its recovery was made possible through collaborative efforts of the Fish and Wildlife Service, U.S. Forest Service, Appalachian Mountain Club, and New England Wild Flower Society to reroute a hiking trail and grow plants for replanting into the wild. (See "An Alpine Plant Comes Back" in *Bulletin* Vol. XXVII, No. 3.)

The delisting rule includes a proposed 5-year monitoring plan, as required for species that are delisted due to recovery. This plan will include monitoring of population trends of both natural and transplanted populations.

Truckee Barberry (*Berberis* (= *Mahonia*) *sonnei*) We proposed on September 3 to remove this plant, a small, colonial evergreen shrub in the family Berberidaceae, from the list of endangered and threatened species due to a taxonomic revision. At the time it was listed, this plant was considered to be a distinct species. The prevailing judgment among plant taxonomists is now that this plant is not a discrete taxonomic entity and therefore does not meet the definition of a species as defined by section 2 of the ESA. Botanists have synonymized *Berberis sonnei* with *Berberis repens*, a common and widespread taxon with a distribution from California northward to British Columbia and Alberta, and eastward to the Great Plains.

Critical Habitat

Critical habitat, as defined in the ESA, is a term for a geographic area that is essential for the conservation of a listed species. Critical habitat designations do not establish a wildlife refuge, wilderness area, or any other type of conservation reserve, nor do they affect actions of a purely private nature. They are intended to delineate areas in which federal agencies must consult with the Service to ensure that actions these agencies authorize, fund, or carry out do not adversely modify the designated critical habitat. Within designated critical habitat boundaries, federal agencies are required to consult except in areas that are specifically excluded, such as developed areas within the boundaries that no longer contain suitable habitat. Maps and more specific information on critical habitats actions listed below are contained in the specific *Federal Register* notice designating each area. For more information on critical habitat designations in general, go to the website for our Endangered Species Listing Program: <http://endangered.fws.gov/listing/>.



Gulf sturgeon

Photo by Robert H. Pos/USFWS

Proposed Critical Habitat Rules

In addition to the critical habitat proposals noted above as part of the listing proposals, proposed designations of critical habitat for previously listed species have been published for the following:

- Ventura marsh milk-vetch (*Astragalus pycnostachyus* var. *lanosissimus*), a coastal plant from southern Oregon and central California, on October 9;
- 4 crustaceans and 11 plants found in vernal pools in California and southern Oregon, September 27;
- nine invertebrates endemic to karst habitats (such as caves, fissures, and sinkholes) in Bexar County, Texas, on August 27;
- Preble's meadow jumping mouse (*Zapus hudsonius preblei*), a small mammal living along rivers and streams in Colorado and Wyoming, on July 17;
- Keck's checkermallow (*Sidalcea keckii*), a plant growing in central California, on June 19;
- two plants, Baker's larkspur (*Delphinium bakeri*) and the yellow larkspur (*Delphinium luteum*) from coastal northern California, on June 18;
- Blackburn's sphinx moth (*Manduca blackburni*), an insect found on the Hawaiian islands of Maui, Hawai'i, Moloka'i, and Kaho'olawe, on June 13;
- Gulf sturgeon (*Acipenser oxyrinchus desotoi*), a fish currently found in rivers flowing into the Gulf of Mexico from Louisiana to Florida,

on June 6;

- Rio Grande silvery minnow (*Hybognathus amarus*), a small fish that formerly occurred throughout most of the Rio Grande but now survives only from Cochiti Dam in Sandoval County downstream to the headwaters of Elephant Butte Reservoir in Sierra County, New Mexico, on June 6;
- 99 endemic plant species known historically from the Hawaiian island of O'ahu, on May 28;
- 47 plant species known historically from the island of Hawai'i, on May 28;
- five plant species on the islands of Nihoa, Necker, and Laysan in the Northwestern Hawaiian Islands, on May 14;
- 46 plant species known historically from the Hawaiian island of Moloka'i, on April 5;
- 61 plant species known historically from the Hawaiian islands of Maui and Kaho'olawe, on April 3;
- Kauai cave wolf spider (*Adelocosa anops*) and Kauai cave amphipod (*Spelaeorchestia koloana*), two invertebrates known only from the Hawaiian island of Kaua'i, on March 27;
- 32 plant species listed known historically from the Hawaiian island of Lana'i, on March 4; and
- five plants species endemic to carbonate soils in the San Bernardino Mountains of southern California, on February 12.

Final Critical Habitat Rules

Final critical habitat rules have been published in the *Federal Register* for the following species:

- two southern California plants, the purple amole (*Chlorogalum purpureum* var. *purpureum*) and Camatta Canyon amole (*Chlorogalum purpureum* var. *reductum*), on October 24;
- Santa Cruz tarplant (*Holocarpha macradenia*) from central California, on October 16;
- three species on Guam, two birds and a fruit bat, on October 15;
- a northern California plant, the Kneeland Prairie penny-cress (*Thlaspi californicum*), on October 9;
- Appalachian elktoe (*Alasmidonta raveneliana*), a freshwater mussel living in streams in North Carolina and Tennessee, on



Appalachian elktoe

Photo by Richard Biggins/USFWS

September 27;

- the northern Great Plains breeding population of the piping plover (*Charadrius melodus*), on September 11;
- Newcomb's snail (*Erinna newcombi*), a freshwater snail endemic to the Hawaiian island of Kaua'i, on August 20;
- Carolina heelsplitter (*Lasmigona decorata*), a freshwater mussel found in North and South Carolina, on July 2;
- Monterey spineflower (*Chorizanthe pungens* var. *pungens*), a central California plant, on May 29;
- Scotts Valley spineflower (*Chorizanthe robusta* var. *hartwegii*), a central California plant, on May 28;
- robust spineflower (*Chorizanthe robusta* var. *robusta*), a central California plant, on May 28;
- San Bernardino kangaroo rat (*Dipodomys merriami parvus*) a small hopping mammal in southern California, on April 23; and
- Quino checkerspot butterfly (*Euphydryas editha quino*) in southern California, on April 15.
















Quino checkerspot butterfly

Photo © B. Moose Peterson/WRP

BOX SCORE

Listings and Recovery Plans as of March 31, 2003

GROUP	ENDANGERED		THREATENED		TOTAL LISTINGS	U.S. SPECIES W/ PLANS
	U.S.	FOREIGN	U.S.	FOREIGN		
 MAMMALS	65	251	9	17	342	52
 BIRDS	78	175	14	6	273	77
 REPTILES	14	64	22	15	115	32
 AMPHIBIANS	12	8	9	1	30	14
 FISHES	71	11	44	0	126	96
 SNAILS	21	1	11	0	33	22
 CLAMS	62	2	8	0	72	57
 CRUSTACEANS	18	0	3	0	21	13
 INSECTS	35	4	9	0	48	29
 ARACHNIDS	12	0	0	0	12	5
ANIMAL SUBTOTAL	388	516	129	39	1,072	397
 FLOWERING PLANTS	570	1	144	0	715	572
 CONIFERS	2	0	1	2	5	2
 FERNS AND OTHERS	26	0	2	0	28	28
PLANT SUBTOTAL	598	1	147	2	748	602
GRAND TOTAL	986	517	276	41	1,820*	999

TOTAL U.S. ENDANGERED: 986 (388 animals, 598 plants)

TOTAL U.S. THREATENED: 276 (129 animals, 147 plants)

TOTAL U.S. LISTED: 1,262 (517 animals**, 745 plants)

* Separate populations of a species listed both as Endangered and Threatened are tallied once, for the endangered population only. Those species are the argali, chimpanzee, leopard, Stellar sea lion, gray wolf, piping plover, roseate

tern, green sea turtle, saltwater crocodile, and olive ridley sea turtle. For the purposes of the Endangered Species Act, the term "species" can mean a species, subspecies, or distinct vertebrate population. Several entries also represent entire genera or even families.

** Nine animal species have dual status in the U.S.

ENDANGERED
Species
BULLETIN

*U.S. Department of the Interior
Fish and Wildlife Service
Washington, D.C. 20240*

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