TITLE: Tamarisk leaf beetle species and impacts on Southwestern Willow Flycatcher, Riparian Avifauna, Herpetofauna, and Microclimate in the Verde River and Tonto River Watershed, AZ

LOCATION: Verde River Watershed and Tonto River Watershed

DATE: September 2010

DURATION: Year 1 of a 2-year project **FUNDING SOURCE:** Base

PROJECT LEADER: John Anhold, FS Entomologist

COOPERATORS: Matthew Johnson, USGS, Northern Arizona University, Erica Nowak, Northern Arizona University, Barbara Ralston, USGS/SBSC,

FHP SPONSOR/CONTACT: John Anhold, Flagstaff FHP, 928-556-2073, janhold@fs.fed.us

PROJECT OBJECTIVES: Identifying the directionality and extent of beetle distributions in two watersheds across Arizona. Establish baseline bird abundance, distribution, and foraging behavior, herpetofauna, microhabitat and plant diversity data prior to beetle infestation using thermistors that record temperature and relative humidity values, ground vegetation surveys to establish types of understory cover, bird and herpetofauna surveys and foraging observations, and identify tamarisk leaf beetle species in the Verde and Tonto Watersheds of central Arizona.

JUSTIFICATION:

a. **Linkage** to FHM Detection Monitoring - After the initial detection of *Diorhabda* in northern AZ in the Fall of 2009, supplemental surveys were conducted in 2010 to determine any range and population density expansion in adjacent areas. Established sampling protocol developed by the Tamarisk Coalition and others was used. In 2010, survey results revealed spread of tamarisk leaf beetle resulting in defoliation of tamarisk into lower sections of Grand Canyon and other sections of N. AZ. The spread of tamarisk leaf beetle (*Diorhabda carinulata*) from the north and potential spread of other species of tamarisk leaf beetle (e.g., *Diorhabda elongate*) from Texas will ultimately affect riparian forests in central Arizona.

b. **Significance** in terms of the geographic scale - Tamarisk Leaf Beetle (henceforth TLB) has rapidly expanded its range since its release to Nevada, Texas and Utah and in the past two years has found its way into northern New Mexico and Arizona. Impacts to tamarisk, native riparian communities, such as avifauna and herpetofauna are widespread in scope. TLB (*Diorhabda carinulata*) has already spread further south and the spread of TLB species from Texas (*Diorhabda elongate*) are expected to continue range expansion into the Verde and Tonto Watersheds. These areas are critical habitat to the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and important to many other riparian obligate breeding birds and herpetofauna.

Biological impact - In the long-term, pronounced changes in habitat structure and composition as a result of beetle establishment are inevitable. Many systems in the Colorado Basin have broad expanses of monotypic tamarisk stands, while other areas have a mixed tamarisk-native plant composition (van Riper et al., 2008). While biocontrol is not expected to eradicate tamarisk, the introduction of beetles to these systems will reduce plant vigor and increase mortality, ultimately leading to a system where tamarisk persists at lower frequencies. The net change in avifauna and herpetofauna productivity in these systems as a result of biocontrol will depend heavily on what plant species are present and what will replace tamarisk. Because tamarisk is capable of growing in areas with little water and high

salinity, desired native plants may not naturally replace tamarisk habitats that are lost to mortality from beetles (Shafroth et al. 2005). A major concern is that these areas will be colonized by non-native plants (e.g., Russian Thistle, (*Salsola tragus)* or Russian Olive, (*Elaeagnus angustifolia*) that provide poorer quality habitat to birds than tamarisk, underscoring the need for active native plant restoration in the wake of beetle establishment. Understanding how avifauna and herpetofauna diversity and abundance vary in relation to habitat composition prior to beetle establishment (e.g., van Riper *et al.* 2008), will help identify key habitat needs for riparian avifauna and herpetofauna of conservation concern, thereby allowing land managers to devise targeted restoration plans that maximize benefits for these species. Defoliation of tamarisk by the TLB may also increase temperatures, reduce relative humidity, and increase light availability to understory plants. Each of these changes in microhabitat variables may affect reproductive success by riparian bird species and resident herpetofauna and understory plant diversity. Defoliation effects have repercussions in ecosystem services associated with riparian habitat as refugia for resident and transient populations and the effect of habitat change on this function/service.

c. **Scientific Basis/Feasibility** - Current sampling methods for detecting and estimating TLB population density and defoliation are well established. Preliminary sampling using these methods in 2010 was very successful and indicates a continued southern and western spread of TLB. Also, the cooperators have experience in completing large scale projects such as this one in collaboration with other groups.

d. **Priority Issues** addressed from Request for Proposals. Six of the nine priority issues are encompassed in the proposal. This work will incorporate climate change, drought, tree mortality, poor crown condition, fragmentation and down woody material.

DESCRIPTION:

a. Background: With or without prior planning, land management agencies on the Colorado Plateau are currently or will soon be living with one or more species of the tamarisk leaf beetle, genus *Diorhabda*. The TLB, which feeds specifically on tamarisk, was approved for release as a biological control agent in certain areas of the west in 2001 to help manage tamarisk. Due to concerns about impacts on the southwestern willow flycatcher, and the rapid and unexpected spread of the beetle, the species has not been released regionally since 2009. Tamarisk (*Tamarix* spp.) is a highly invasive plant native to Eurasia that grows along the Colorado River and in riparian habitats throughout the southwest. It is particularly successful in areas with altered flow regimes, impacts water resources, native plant diversity, wildlife habitat, and recreation, and poses an increased wildfire risk where it grows in dense stands. Prior to TLB, the plant was controlled primarily by herbicides, mechanical thinning and fire, often at great costs. Throughout the southwest, tamarisk has altered the composition of native riparian forests, and the beetle's expansion will continue to alter their trajectory, yet, baseline information in areas yet to be invaded by the beetle's and their effect on the riparian avifauna, herpetofauna and microclimate in Northern Arizona is unavailable due to limited staff and funding available to complete field sampling.

The rates at which vegetation changes in composition will occur, and the resultant effects on riparian-dependent avifauna and herpetofauna that breed in tamarisk are presently unknown. Effects on riparian vegetation communities will likely include changes in plant biomass, microclimate changes, and plant species diversity (Busch and Smith 1995). These changes could potentially have a profound impact on migratory and breeding avifauna and resident herpetofauna within riparian corridors throughout the southwest (van Riper et al. 2008, Hultine et al. 2009) and particularly in those areas where tamarisk is the dominant overstory plant.

Our objectives are to, in conjunction with TLB surveys and taxonomy, 1) document riparian avifauna and herpetofauna abundance in areas with extensive stands versus little to no tamarisk (*Tamarix ramosissima*) currently present as a baseline; 2) compare the species and their abundance to areas where tamarisk beetle is present and has defoliated extensive areas of tamarisk; 3) document the species of birds and herpetofauna that feed on the beetle; and 4) through on-site measurements, test our prediction that increased temperature and decreased humidity could decrease avifauna and herpetofauna species richness and abundance.

b. Methods:

Tamarisk Leaf Beetle Surveys

Ideally, to detect beetles in previously uncolonized areas, we would deploy traps with synthetic pheromones developed for this use. However, the Agricultural Research Service is no longer producing the TLB pheromone (T. Dudley, pers. comm.). T. Dudley (pers. comm.) and his research group are attempting to establish more large-scale sampling (i.e., across the Colorado Basin) that would involve securing funding for, and finding a manufacturer of pheromone traps. We will continue to collaborate with them and attempt to pursue, and eventually test, this sampling method. Currently, it is beyond the temporal and budgetary scope of this proposal, we will employ established TLB survey methods.

The survey methods for tamarisk leaf beetle are based on those established by the Tamarisk Coalition, with modification. The standard Tamarisk Coalition survey method includes 5 sweeps on each of 5 randomly selected plants at each sample site, with each site sampled 3 times a year, including May, July and late August. Researchers working in areas entirely outside of the known area of TLB colonization have found that more intensive sampling at sites is more effective in detecting TLB at low density, low pheromone levels, and with no aggregation (T. Dudley, pers. comm.). This Intensive Survey Method consists of a minimum of 100 (average 300) "haphazard" sweeps made throughout a site. We will employ this Intensive Survey Method in all sites, until TLB are detecting at a site. Once detected at a site, we will employ the standard Tamarisk Coalition survey methods at the sites where TLB have been detected. Survey sites will be selected throughout the greater Verde River Watershed and Tonto River Watershed. Surveys will be conducted along riparian zones of the principal rivers and streams, within the Verde and Tonto Watersheds with a minimum of 1.5 km between sites. Also, critically important sites will be sampled, such as springs and wetlands where high levels of biodiversity occur. At each site, the number of different instars and adults is tallied for each set of 5 sweeps. TLB will be collected, placed in vials with alcohol for taxonomic species identification. Other site data will also be collected, including vegetation community, percent defoliation of tamarisk, aspect, substrate and geology, elevation, location, and other relevant variables. For the purposes of long-term monitoring, two additional methods will be implemented. First, in sites where TLB are detected, the vegetation in a 0.1 circular hectare plot centered on the area where the 5 sweep sets are done will be described using a standard releve (plot) method, listing the abundance and cover of all species in the plot. Second, the five plants that were swept for beetles will be tagged so they can be re-located, and diameter at ground level will be determined for fuel loading calculations. The fate of these 5 plants will be followed over time to determine how long it takes to kill individual trees. Preliminary tests of these methods were done in the 2010 field season with success. For each survey we will document type of survey, location (UTM), date, surveyor name, temperature, wind speed, and precipitation.

Avian Point Count Surveys

Variable-radius point count surveys stations will be established 200 m apart within riparian vegetation, at least 50m from the edge, and in habitats composed of varying degrees of tamarisk and native trees

(e.g., willows, cottonwoods, mesquite), ranging from monotypic tamarisk to mostly native trees. Point count surveys will last 8 min and all species detected by sight or sound will be recorded, along with their distance from the point, mode of detection (e.g., visual, song, call, etc), sex, and age. Each station will be surveyed three times from 15 May to 30 June (breeding season). During each survey, field technicians will assess the foliage condition on existing tamarisk trees in each of the cardinal directions by assigning percentage values to foliage in the following categories: green, yellow (caused by tamarisk leaf-hoppers, *Opsius stactogalus*), brown, defoliated and regrowth.

Avian Foraging Observations

To develop baseline, pre-invasion bird foraging data, each site will be systematically searched to locate foraging birds and observations will be made on birds throughout the riparian patch. Individual birds (e.g. yellow warblers (*Dendroica petechia*), Lucy's warbler (*Vermivora luciae*) will be followed using a focal animal approach with continuous recording (Martin and Bateson 1986). Foraging observations will last as long as the bird is in sight. For each observation, we will record the bird species, number of prey attacks (attempts to capture insect prey), tree species where attacks occurred, and movements between attacks: hops, short flights (<1 m), and long flights (>1 m) (Pomara et al. 2003). All observations will be continuously recorded on a digital recorder. Foraging observations will also be made, using these methods, at sites where beetles are detected. In addition, we will document all bird species observed feeding on TLB adults, larvae, or pupae.

Herpetofauna Surveys

We will survey for riparian herpetofauna using diurnal visual encounter surveys (Crump and Scott 1994, Person and Nowak 2006). Each visual encounter survey will consist of one-two persons (with occasional additional volunteers) walking for one hour during the morning in 100-m^2 plots within each site. We will use binoculars to search for reptiles and amphibians in all reasonable areas within that habitat, and will flip cover under which animals may be sheltering. Each site will be visited at least six times per year in conjunction with the bird and TLB surveys.

Microclimate Methods

In each riparian system we will develop a sampling schedule for deploying thermistors to collect data on temperature and relative humidity and conduct understory plant surveys within each drainage. Sampling for vegetation will take place in late spring to estimate overstory cover. Defoliation estimates will be determined in the fall when thermistors are collected.

c. Products: All field data sheets will be compiled, scanned and entered into an MS Access spreadsheet and/or regional database. The spatial data for each sampling location and the *Diorhabda* numbers present will be entered into GIS and used to create a map. We will also report our findings identifying what *Diorhabda* species are present in the Verde and Tonto Watersheds of central Arizona. The data will be submitted to the Tamarisk Coalition as part of their regional effort to coordinate and compile *Diorhabda* monitoring datasets. A post-season report will be produced each year of the project and a final report will summarize TLB population expansion, spread and taxonomy. Baseline data for avifauna abundance and foraging observations, herpetofauna abundance, baseline microclimate (temperature and relative humidity), and baseline vegetation cover .

d. Schedule of Activities:
March – Plan field schedule and river / backcountry logistics; coordinate with partners

Field staff training & initial survey and plot establishment work.
April – June – Deploy thermistors, conduct avian and herpetofauna surveys
April – early September – Conduct Diorhabda field sampling
October – Enter field data; prepare annual report; provide data to regional database

e. **Potential collaborators:** Additional organizations that are interested in the proposed watersheds and possible financial assistance in future years.

There are number of organizations that may assist in this effort in future years. 1. Arizona Water Protection Fund. An organization that contributes to long term monitoring of riparian habitat and water resources throughout Arizona. 2. National Park Service (i.e. Montezuma Castle National Monument, Montezuma Well National Monument, Tuzigoot National Monument) in the Verde Watershed adjacent to Dry Beaver Creek and Verde River. These National Monuments have contributed to our research of riparian obligate birds (southwestern willow flycatcher, yellow-billed cuckoo, common black-hawk) and factors that affect their riparian breeding habitat. 3. Arizona Game and Fish Department Heritage Grant Program and Wildlife Conservation Fund have also contributed funding to inventory and monitoring of yellow-billed cuckoo, common black-hawk and gray hawk in the Verde River Watershed and San Pedro River Watershed. Both programs are involved in the long term health and management of riparian ecosystems throughout Arizona 4. San Pedro River Conservation Area. Funding for an inventory of all riparian raptors has come from; The National Landscape Conservation System (NLCS) Research and Science Program. This program provides financial support for science projects that work to answer fundamental science questions within NLCS units and for the larger National Public Lands System as a whole.

f. Literature Cited

Busch, D.E., and S.D. Smith. 1995. Mechanisms associated with decline of woody species in riparian ecosystems of the southwestern U.S. Ecological Monographs. 65:347-370.

Crump, M., and N. Scott. 1994. Visual encounter surveys. pp. 84-92 *In* M. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, eds. Measuring and Monitoring Biological Diversity: Standard methods for amphibians. Smithsonian Institution Press, Washington D.C.

Hultine, K.R., Belnap, J., van Riper, C, III, Ehleringer, J.R., Dennison, P.E., Lee, M.E., Nagler, P.E., Snyder K.A., Uselman, S.M., and West, J.B., 2009, Tamarisk biocontrol in the western United States: ecological and societal implications; Frontiers in Ecology and the Environment e-View. doi: 10.1890/090031.

Martin, P., and P. Bateson. 1986. Measuring Behavior: an introductory guide. Cambridge University Press, New York.

Pamora, L.Y., R.J. Cooper, and L. J. Petit. 2003. Mixed-species flocking and foraging behavior of four neotropical warblers in Panamanian shade coffee fields and forests. Auk 120(4):1000-1012.

Persons, T. B., and E. M. Nowak. 2006. Inventory of amphibians and reptiles in Southern Colorado National Parks. USGS Southwest Biological Science Center Open-File Report 2006-1132.

Shafroth, P. B., J. R. Cleverly, T. L. Dudley, J. P. Taylor, C. van Riper III, E. P. Weeks, and J. N. Stuart. 2005. Control of Tamarix in the western United States: Implications for water salvage, wildlife use, and riparian restoration. Environmental Management 35:231-246.

van Riper, C., III, K. Paxton, C. O'Brien, P. Shafroth and L. McGrath. 2008. Rethinking avian response to tamarisk on the lower Colorado River: A threshold hypothesis. Restoration Ecology 17: 152-164 (March issue). http://charlesvanriper.com/papers/2009/rethinking_avian_response.pdf

COSTS: Budget estimates for the project (future projections based on 2% COLA and cost increases).

BUDGET (assumes 13 weeks fieldwork/year)	**REQUESTED**	**REQUESTED**	**CONTRIBUTED**	**CONTRIBUTED**
PERSONNEL SERVICES	**FY11**	**FY12**	**FY11**	**FY11**
USGS Research Ecologist (Barbara Ralston)			$4,500	$4,500
1 Project Manager-Johnson@26.55/hr x 20 hours x 6 wks	$4,137.00	$4,214.00	$0	$0
Benefits @43%	$1,778.91	$1,812.02	$0	$0
1 Bird Technician 40 hrs/wk. @ $14/hr. (13 wks)	$7,840.00	$8,008.00	$0	$0
1 Bird Technician Benefits @ 8.22%	$644.45	$658.26	$0	$0
Project Manager-Nowak@$33/hr x 20 hrs x 6wks	$4,620.00	$4,725.00	$0	$0
Project Manager ERE @ 0.43	$1,986.60	$2,031.75	$0	$0
1 Herp Technician 40 hrs/wk@ $14/hr (13 wks)	$7,840.00	$8,008.00	$0	$0
1 Herp Technician ERE @ 8.22%	$644.45	$658.26	$0	$0
2 Volunteers @ $10/hr	$0	$0	$2,000	$2,000
TOTAL PERSONNEL COSTS:	**$29,491**	**$30,115**	**$6,500**	**$6,500**
TRAVEL AND TRANSPORTATION COSTS				
Mileage @ $0.445/mile x 4000 miles	$1,780	$1,780	$0	$0
Per diem at $20/night	$1,920	$1,920	$0	$0
NAU vehicle rental @ $250/wk	$3,500	$3,500	$0	$0
TOTAL TRAVEL/TRANSPORTATION COSTS:	**$7,200**	**$7,200**	**$0**	**$0**
SUPPLIES AND EQUIPMENT				
Binoculars, animal measuring & weather equipment	$50	$50	$2,500	$0
Garmin GPS unit	$0	$0	$600	$0
Expendables (batteries, flagging, bait, etc.)	$100	$100	$0	$0
TOTAL SUPPLIES AND EQUIPMENT COSTS:	**$150**	**$150**	**$3,100**	**$0**
TOTAL DIRECT COSTS:	**$36,841**	**$37,465**	**$9,600**	**$6,500**
NAU OVERHEAD @ 0%	**$0**	**$0**	**$0**	**$0**
TOTAL COSTS	**$36,841**	**$37,465**	**$9,600**	**$6,500**

NPS In-Kind salary estimate for GS 12 for 2 pp
Other In-Kind: Tamarisk Coalition volunteer and crew support

MATTHEW J. JOHNSON

Research Associate, Northern Arizona University, Colorado Plateau Research Station
Box 5614, Flagstaff, AZ 86011, (928) 523-7764, matthew.johnson@nau.edu

EDUCATION

Master's of Science – Biology. May 1997. Northern Arizona University, Flagstaff, AZ.
Bachelor of Science – Zoology. 1990-1992. Weber State University, Ogden, UT.
Bachelor of Arts – Education. 1983. Western State College, Gunnison, CO.

WORK EXPERIENCE

2006-Present Ecologist, U.S. Geological Survey (Southwest Biological Science Center)
1993-Present Research Biologist, Senior, Northern Arizona University, Flagstaff, AZ.

AREAS OF EXPERTISE

- Design and implementation of a long term bird monitoring programs
- Assessing bird habitat relationships at a range of spatio-temporal scales
- Management approaches to conservation of at-risk species
- Using bird species as indicators of ecosystem health

SELECTED PUBLICATIONS

Etzel, K.E, T.C. Theimer, **M.J. Johnson**, J.A. Holmes. In review at Condor. Prey Delivery at Common-Black Hawk (*Buteogallus anthracinus*) nests and the importance of Exotic Crayfish.

Johnson, M.J.., R. T. Magill, and C. van Riper, III. 2010. Yellow-billed Cuckoo Distribution and Habitat Associations in Arizona, 1998-1999: Conservation and Management Implications. Proceedings of the Ninth Biennial Conference on Research in Colorado Plateau, 25-28 October 2007.

Kelly, J., **M.J Johnson**, S. Langridge, and M. Whitfield. 2008. Efficacy of stable isotope ratios in assigning endangered migrants to breeding and wintering sites. Ecological Applications. 18(3):568-576.

Johnson, M.J., S.L Durst, C.M. Calvo, L. Stewart, M.K. Sogge, G. Bland, and T. Arundel. 2008. Yellow-billed Cuckoo distribution, abundance, and habitat use along the lower Colorado River and its tributaries, 2007 Final Report: U.S. Geological Survey Open-File Report 2008–1177, 268 pp.

Holmes, J.A., **M.J. Johnson** and C. Calvo. 2008. Yellow Billed Cuckoo distribution, habitat use and breeding ecology in the Verde Watershed of Arizona, 2003-2004. Final Report, Arizona Game and Fish Heritage Program, Phoenix, Arizona, 174 pp.

Johnson, M.J., and C. van Riper, III. 2004. Cowbird brood parasitism of the Black-throated Sparrow in the Verde Valley of central Arizona. Journal of Field Ornithology. 75(3):303-311.

Johnson, M. J., C. Van Riper, III, and K. M. Pearson. 2002. Black-throated Sparrow (*Amphispiza bilineata*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; http://bna.birds.cornell.edu/bna/species/637doi:bna.637.

RECENT GRANTS

- Examining the presence of the tamarisk leaf beetle in Grand Canyon National Park. **($8,500)**
- Determining distribution, habitat use and presence of riparian raptors within the Verde Watershed, AZ. **($68,045)**
- Common Black Hawk nests in the Verde River Watershed and the importance of exotic crayfish. **($15,485)**
- Forecasting climate impacts on wildlife of the arid southwest at regional and local scales using downscaled climate models. **($1,670,897)**
- Riparian Raptors: distribution, abundance, habitat requirements, and breeding ecology at the San Pedro River Preserve. **($65,348)**

ERIKA NOWAK

Research Associate, Colorado Plateau Research Station, Box 5614, Northern Arizona University, Flagstaff, Arizona 86011 ph. (928) 523-7760

EDUCATION

PhD, **Biology**. Northern Arizona University, 2009.
MS, **Biology**. Northern Arizona University, 1998.
BS, **Wildlife Biology**. Cornell University, 1991

EMPLOYMENT

- 1992-present: Research Associate. USGS Southwest Biological Science Center and Northern Arizona University Colorado Plateau Research Station, Flagstaff, Arizona.
- 2009: Part-time Faculty. Department of Biological Sciences, Northern Arizona University, Flagstaff, Arizona.
- 1998-2004, 2009: Principal Scientist. Erika M. Nowak Herpetological Consulting, Flagstaff, Arizona.

SELECTED RECENT PUBLICATIONS

Nowak, E.M. and T.B. Persons. 2010. Milksnakes at Petrified Forest National Park, Arizona: Implications for monitoring rare vertebrates. pp. 133-150 In C. van Riper III, B.F. Wakeling, and T.D. Sisk, editors. *Proceedings of the 9th Biennial Conference of Research on the Colorado Plateau*. University of Arizona Press, Tucson, Arizona.

Hamilton, B.T., and **E.M**. **Nowak**. 2009. Relationships between insolation and rattlesnake hibernacula. *Western North American Naturalist* 69: 319-328.

.**Nowak, E.M**., T. Theimer and G.W. Schuett. 2008. Functional and numerical responses of predators: where do vipers fit in the traditional paradigms? *Biological Reviews* 83: 601-620.

Persons, T.B., **E. M**. **Nowak**, and D. Mikesic. 2008. Overview of herpetofauna inventories in Southern Colorado Plateau National Parks. *In* C. van Riper III and M. Sogge, editors. *Proceedings of the 8th Biennial Conference of Research on the Colorado Plateau*. University of Arizona Press, Tucson, Arizona.

Persons, T.B., and **E.M. Nowak**. 2006. Inventory of Amphibians and reptiles at Death Valley National Park. USGS Southwest Biological Science Center Open-File Report 2006-1233.

Persons, T.B., and **E.M**. **Nowak**. 2005. *Hypsiglena torquata* (distribution record). *Phrynosoma modestum* (distribution record). *Herpetological Review* 36(1): 80, 82.

Nowak, E.M., T. Hare, and J. McNally. 2002. Management of "nuisance" vipers: Effects of translocation on Western Diamondback Rattlesnakes (*Crotalus atrox*). pp. 533-560 *In* G.W. Schuett, M. Höggren, M.E. Douglas, and H.W. Greene, editors. *Biology of the Vipers*. Eagle Mountain Publishing, LC, UT (USA).

RECENT GRANTS

- 2010-2011: Radio-telemetric Research on Mexican Gartersnakes at Tavasci Marsh, Arizona. Joint project between National Park Service and NAU. (PI, NAU). $**24,556** ($10,000 to NAU).
- 2010-2012: Herpetological and Small Mammal Surveys of the Expansion Areas of Petrified Forest National Park. National Park Service. (PI, NAU). **$63,000**.
- 2009-2010: Aquatic Herpetofauna Surveys of Prescott National Forest. US Forest Service. (PI, NAU). **$22,488**.
- 2008-2012. Watson Woods Preserve Restoration Plan, Reptile and Amphibian Monitoring. Arizona Water Protection Fund grant to Prescott Creeks Preservation Association. (PI, NAU). **$108,000**.

BARBARA E. RALSTON

Biological Scientist, Grand Canyon Monitoring and Research Center, Southwest Biological Science Center, U.S. Geological Survey, Flagstaff, AZ 86001, Phone 928-556-7455, Fax 928-556-7092, Email: bralston@usgs.gov

EDUCATION

Ph.D.	Northern Arizona University, Flagstaff, Arizona	1993	Botany
M.S.	Sul Ross State University, Alpine, Texas	1987	Biology
B.S.	Kansas State University, Manhattan, Kansas	1984	Physical Science

CURRENT POSITION

December 2005 – present: Biological Scientist GS12/7– Grand Canyon Monitoring and Research Center. Serves as lead terrestrial biologist for monitoring and research for the Grand Canyon Monitoring and Research Center as part of the Glen Canyon Adaptive Management Program.

AREAS OF EXPERTISE

- Participate in the development of integrated projects that answer management questions about the effects of river regulation on natural resources
- Plan, develop, recommend, and implement monitoring programs for riparian vegetation and associated wildlife along the Colorado River below Glen Canyon Dam
- Coordinates research and monitoring efforts with other Department of Interior Agencies (NPS, Bureau of Reclamation, BIA)
- Collect and analyzes riparian vegetation data for long-term monitoring of riparian vegetation along the Colorado River corridor including applying information to production of vegetation map for the purposes of change detection.

RELEVANT PUBLICATIONS

Kennedy, T.A., and *Ralston, B.E.,* 2010. Regulation leads to increases in riparian vegetation, but not direct allochthonous inputs, along the Colorado River in Grand Canyon, Arizona, River Research and Applications. DOI:10.1002/rra.1431.

Ralston, B. E., 2010, Riparian vegetation response to the March 2008 short-duration, high-flow experiment—implications of timing and frequency of flood disturbance on nonnative plant establishment along the Colorado River below Glen Canyon Dam: U.S. Geological Survey Open-File Report 2010–1022, 30 p.

Ralston, B.E., Davis, P.A., Weber, R.M., and Rundall, J.M., 2008. A vegetation database for the Colorado River ecosystem from Glen Canyon Dam to the Western Boundary of Grand Canyon National Park, Arizona. U.S. Geological Survey Open-file Report 2008-1216, 37 p.

Publications In Preparation:

Ralston, B.E., Summary report of response of key resources to the 2000 low steady summer flow experiment: U.S. Geological Survey Open-File Report *in review.*

JOHN A. ANHOLD

Forest Entomologist, USFS Southwestern Region, Rocky Mountain Research Station, 2500 S. Pine Knoll Dr., Flagstaff, AZ 86001 ph. 928-556-2073, janhold@fs.fed.us

EDUCATION:

M.S. Forestry 1986 Utah State University, Logan UT.

B.S. Forestry 1983 Utah State University, Logan UT.

WORK EXPERIENCE:

2000-present Supervisory Entomologist, Forest Health Protection, USDA Forest Service. Flagstaff, AZ

1990-2000 Entomologist, Forest Health Protection, USDA Forest Service. Ogden, UT.

1988-1990 Entomologist, Forest Health Protection, USDA Forest Service. Durham, NH.

PUBLICATIONS – Past 5 Years:

Fettig, J.C., J.D. McMillin, **J.A. Anhold**, S.M. Hamud, R.R. Borys, C.P. Dabney, and S.J. Seybold. 2006. The effects of mechanical fuel reduction treatments on the activity of bark beetles (Colioptera: Scolytidae) infesting ponderosa pine. Forest Ecology and Mgt. 230: 55-68.

DeGomez, T.E., C.J. Hayes, **J.A. Anhold**, J.D. McMillin, K.M. Clancy and P.P. Bosu, 2006. Evaluation of insecticides for protecting southwestern ponderosa pines from attack by engraver beetles (Coleoptera: Curculionidae: Scolytinae). J. Econ. Entomol. 99(2): 393-400.

Carolyn, H.S., J.D. McMillin, J.F. Fowler, K.K. Allen, J.F. Negron, L.L. Wadleigh, **J.A. Anhold** and K.E. Gibson. 2006. Best predictors for postfire mortality of ponderosa pine trees in the Intermountain west. Forest Science. 52(6), 718-728.

DeGomez, T., C.J. Hayes, **J.A. Anhold**, J.D. McMillin and K.M. Clancy. 2007. Evaluation of insecticides for protecting Arizona Cypress (*Cupressus arizonica*) and one-seed juniper (*Juniperus monosperma*) from attack by *Phloeosius* bark beetles. Arboriculture & Urban Forestry. 33(3): 162-167.

C.J. Hayes, T.E. DeGomez, K.M. Clancy, K.K. Williams, J.D. McMillion, **J.A. Anhold**. 2008. Evaluation of funnel traps for characterizing the bark beetle (Coleoptera: Scolytidae) communities in ponderosa pine forests of North-Central Arizona. J. Econ. Entomol. 101(4): 1253-1265.

C.J. Hayes, T.E. DeGomes, J.D. McMillin, **J.A. Anhold** and R.W. Hofstetter. 2008. Factors influencing pine engraver (Ips pini Say) colonization of ponderosa pine (Pinus ponderosa Dougl. Ex. Laws.) slash in Northern Arizona. Forest Ecology & Mgt. 255:3541-3548.

Hansen, M.E., J.F. Negron, A.S. Munson**, J.A. Anhold.** 2010. Retrospective assessment of partial cutting to reduce spruce beetle-caused mortality in the Southern Rocky Mountains. West. J. Appl. For. 25(2) 81-87.

Fowler, J.F. C. Hull Sieg, J.D. McMillin, K.K. Allen, J.F. Negron, L.L. Wadleigh, **J.A. Anhold** and K.E. Gibson. 2010. Development and validation of postfire crown damage mortality thresholds in ponderosa pine. International Journal of Wildland Fire. 19:583-588.

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